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THE EFFECT OF DATA-DRIVEN FEEDBACK AND COACHING USING A MIXED-REALITY SIMULATION IN A PRESERVICE TEACHER EDUCATION PROGRAM

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Abstract

This research focused on the inquiry skill of questioning used as a teaching tool and how undergraduate preservice teacher-preparatory program. The instructional strategy of questioning took place in a classroom that used a mixed-reality simulation system. The research design was a mixed-methods procedure. The quantitative aspect included a quasi-experimental design with a treatment group (those who received data-driven feedback and coaching, $n = 15$) and a comparison group (those who did not receive data-driven feedback/coaching, $n = 15$). A comparison of self-efficacy means between groups, indicated no differences before or after the treatment. A Chi-Square procedure and Sign follow-up tests were used to analyze these questioning data. The Chi-Square analysis revealed a significant difference between questioning performance between the treatment and comparison groups, ($\chi^2(1) = 47.56$, $p < .01$). The Sign tests showed statistically significant change in performance in creating Higher-order Thinking (HOT) questions across all three pairwise sessions, for the treatment group p ranged between .002-.005. The comparison group had no significant differences between any sessions. Qualitative data were collected during feedback and coaching sessions with treatment-group participants after each presented a lesson in a mixed-reality simulation environment. Participants from both groups were interviewed at the end of the study. The themes that emerged were data-

driven feedback and coaching improves self-efficacy, planning for a lesson requires reflection, lesson performance is enhanced by reflection, and data-driven feedback and coaching improves questioning skills. This study describes how to improve modern preservice teacher-preparatory programs as they shift toward connecting well-established skills with new-age training technology.

APPROVAL PAGE

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Presented by

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DEDICATION

This research is dedicated to my father Thomas DeSantis who was successful at one of the hardest jobs in the world, being a single parent. Working two jobs over 60 hours a week and raising two sons, it was his determination and grace that made me the man I am today. Thank you, for all the love and support you have given me.

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CHAPTER ONE: INTRODUCTION

Across the United States, preservice teacher-preparatory programs are accredited on both national and state levels (CAEP, 2016). These programs follow similar steps and methods towards assisting preservice teachers to be ready to teach in pre-k to grade 12 classrooms. While these teacher candidates complete classes for subject area mastery, they also register for courses in educational theory, methods, and special topics. To date, this is what the typical education student encounters before engaging in student teaching (CAEP, 2016). In some initial certification programs, candidates might apply for student teaching having only participated to a minor degree in teaching a group of students in a pre-k through grade 12 setting.

There are many ways a preparatory program can provide students with teaching experience, such as volunteer work within community programs or after school clubs. However, it can be difficult for professors to gain insight into the performance of their students and provide direct feedback, when opportunities to work in off-site K-12 schools are limited. When a supervisor has the ability to witness all aspects of a classroom interaction between a teacher candidate and his or her students, the direct feedback provided by the supervisor can ensure deeper learning opportunities for the preservice teacher. With the advent of modern videogame engines and broadband telecommunication access, one can now simulate a variety of classroom experiences at any point in a preservice teacher's preparatory program.

The simulation system, which was originally called TeachLivE (2015), is also provided through a company called Mursion (2015). The system allows a preservice candidate to teach a class within a simulated classroom environment. The candidate stands before a large HDTV and a webcam. The TV displays a virtual classroom complete with students. The camera is used to track where the subject is with respect to the TV, the room, and the students in the virtual world.

Wherever the candidate moves within the room, the TV will move the image of the classroom to the appropriate location. This gives a preservice participant the feeling of teaching in a real classroom.

At the source of the TV there are five simulated students. Each has his or her own background, ethnicity, personality, behaviors, and learning needs. A request can be made for the students to reflect different ages and diverse behavioral scenarios. The classroom can also depict various content areas; thus, tailoring the experience for each preservice teacher. The students are not run by game-engine intelligence, but rather by individuals trained by Mursion, referred to as avatars. The program is based on the premise that "Interactivity during gameplay, such as competition and collaboration with others, plays an important role [in] contributing to [a] learners' motivation, engagement, and development of complex problem-solving competencies" (Eseryel et al., 2014, p. 51). Candidates who participate within the mixed-reality classrooms can increase their engagement with their content area because of the interactional aspects within the simulation environment. The programmed intelligence within the game can connect a student to his or her own personal experiences with the content. Through the programmed intelligence one could adjust the content presentation or difficulty level to challenge the preservice teacher in real time, thus scaffolding learning across a controlled gradient. As Whitton (2012) noted "Scaffolding through increasingly difficult levels allows learners to gradually take more control over their learning and immediate, contextual feedback supports the transition from novice to expert" (p. 249).

With the mixed-reality simulation, one can create an environment that supports preservice teachers in their training to generate lessons with deep learning and student engagement. However, without the context of fostering good teaching practices, a system does

not fully accomplish its task. Questioning is a primary tool for the educator. However, "merely asking questions does not cause students to think. Higher-level questions invite and encourage higher levels of critical thinking in students" (Kipper & Rüütmann, 2010, p. 47). Experienced teachers know that asking questions that involve complex thought processes is influential in students' understanding of the material. "Classroom contexts that fulfill students' basic psychological needs of competence, autonomy, and relatedness by providing, respectively, structure, autonomy support, and teacher involvement are linked with successful academic performance" (Lutz, Guthrie, & Davis, 2006, p. 5). Having students engage in complex thought allows them to connect with the content in a more meaningful way. Preservice teachers must be made aware of and trained to make questioning a key teaching tool. This can be done by measuring a preservice teacher's performance within a lesson and coaching him or her accordingly. By connecting this method to the use of the simulation system we can potentially provide meaningful gains for preservice teachers within a safe and controlled environment.

Rationale

Studying the behavior of preservice teachers in a mixed-reality simulation environment is a great opportunity to understand how a simulation can aid in improving skills for preservice teachers in a teacher-preparatory program. By using this simulation, one can study the effects of a treatment in a controlled and easily measurable environment. The environment allows researchers to create and test treatments or generate scenarios for candidates "on demand" that could be difficult to come across in the real world. Prior notice is given to the avatars through the personnel at Mursion and they are prepared to engage in classroom behavior related to any subject area, at any grade level, and for degrees of behavior that range from normal (level 1) to highly disruptive (level 6). The preservice candidate can practice a particular performance

without fear of causing any concern among students in a real classroom setting. When and how preservice teachers will be given feedback is key to the current research. It is important to note that the type of feedback these preservice teachers receive is the focus of the study and not the simulator. A particular session can be organized to provide feedback during or after a lesson is taught. The opportunity for preservice teachers to receive feedback is important for their growth (Blackley et al., 2017). Blackley et al. reinforce the notion that feedback should be provided with appropriate context in order for the preservice teacher to address specific areas in need of improvement. If performance data can be part of the feedback, then progress can be gauged as the candidate moves through the program. This study was planned to provide feedback about the numbers and types of questions a teacher candidate used after each of three mixed-reality sessions. A coaching discussion also occurred to assist candidates in planning for the subsequent session.

Statement of the Problem

What type of impact does a mixed-reality simulation have on preservice teachers, when connected with best teaching practices regarding feedback and coaching? This overarching question is based on the premise that higher-order thinking is an important skill that all teachers must promote in the classroom (Salinas & Blevins, 2014). There has been an extensive amount of research conducted on how instructional feedback is given to educators both in the field and in a preservice environment. Delcourt and McKinnon (2011) found that giving data-driven feedback and coaching to teachers improved the number of higher-order questions asked by both teachers and students in the classroom. Averill, Drake, and Harvey (2013) examined the use of in-the-moment coaching in a mathematics teacher education course where participants felt that it positively affected their lesson performance. With access to mixed-reality simulation

technology, Khalil, Gosselin, Hughes, and Edwards (2016) studied improvements in preservice mathematics teachers' lesson performance as they used the simulation over a period of time. However, with simulated environments coming into use within teacher-preparatory programs, there is a need to study this emerging technology with well-established methods. This study explored connecting those methods with a mixed-reality simulator. Currently, there is no systematic use of coaching related to this type of experience, and no research regarding how the addition of a robust coaching experience addresses the needs of preservice teachers as they learn to improve their use of questioning skills.

Significance of the Research

By studying mixed-reality simulations in education, we further our understanding of implementing simulation environments within preservice teacher-preparatory programs. Studying the type of feedback given is also important in training a preservice teacher (Francis, 2016). How preservice teachers respond to feedback and coaching is the main drive of this research. Connecting the topics of simulation and feedback we can gain insight into both. The findings in this study may well be a springboard for studying other aspects of mixed-reality simulations and feedback methods used in preservice teacher-preparatory programs.

This research will also create a new type of dynamic between the participant using the simulated teaching environment and a coach. This dynamic will follow the participants in the treatment group in the same fashion that a master teacher or administrator would follow a new teacher throughout a school year. In the case of preservice teachers, this coach will observe their lessons, give private feedback to each participant, and track their growth throughout the semester. This will hopefully create an analog to what a first-year teacher will experience in the field and lead to the creation of new coaching standards in the implementation of simulated

teaching environments. It is important to state here that a mixed-reality simulation does not replace teaching in front of an actual class of students but serves as a scaffolding experience that bridges the gap between having little to no teaching experience to being placed in a professional development school (PDS) for an internship.

Literature Supporting Feedback, Coaching, and Reflection

Feedback, Coaching, and Reflection

The types of feedback preservice teachers receive about the actions that they preform can impact the growth they have in regard to mastering a skill or making a decision. This concept about the relationship between feedback and performance is described in Bandura's social cognitive theory (1986). A major construct within social cognitive theory is known as self-efficacy. Self-efficacy is the level of certainty in an individual's perception of being able to perform an action or make a decision to achieve the desired results. According to Bandura (1986, 1994, 1997), there are four dimensions underlying one's self-efficacy. The mastery of experiences, one's secondhand experience, the amount or type of social encouragement received, and how the individual responds to stressors. Reflection is dependent on one's level of known information and the reconciliation of that information with evidence (Boody, 2008). For educators, reflection and coaching using data-driven feedback has had an important impact on classroom practices and student performance (Barak & Shakhman, 2008; Delcourt & McKinnon, 2011; Reinke, Stormont, Herman, & Newcomer, 2013).

An often-used tool that educators employ to create in-depth learning experiences is questioning. The type of questions a teacher asks can shape how a student learns content (Salinas & Blevins, 2014). Engaging in higher-order thinking requires the learner to critically reflect on the knowledge with which he or she has been presented. The learner must connect

information to create new ideas and solve complex problems or issues that might not have clear answers (Jaramillo, 1996). The purpose of this study was to improve the use of inquiry skills for preservice educators by using data-driven feedback and coaching after each lesson that took place in a mixed-reality simulation environment.

Educational Simulations

Videogame simulations are now providing new dimensions to how we learn and teach. Since the early 1990s, flight schools have been using Microsoft Flight Simulator to train pilots (Homan & Williams, 1998). The original purpose of the game was for home entertainment use only, but after being on the market for a few years, pilots took note of how the game actually copied and reinforced the skills for flying a plane. It was a logical choice to use this simulation game to give flight students experience before they sit in a cockpit. For the past two decades, the Federal Aviation Administration (FAA) has counted hours logged using the Microsoft Flight Simulator toward those required for getting a pilot permit (Homan & Williams, 1998). A simulation experience lends itself well to specialized subjects that require hands-on experience such as education, which includes a broad spectrum of subject areas (Shah & Foster, 2014).

Definition of Terms

1. **Avatars** are the computer-generated students that one can teach in a mixed-reality simulator. They are controlled both by computer software and a human actor (Mursion, 2015).
2. **Coaching** in education occurs when a knowledgeable person (the coach) works one-on-one with a teacher (or preservice teacher), providing guidance, feedback on performance, and other resources as needed. The coach focuses on practical strategies for improving student learning (Delcourt & McKinnon, 2001). In this

study, the researcher was the coach who contacted the preservice teacher, usually by phone, to give performance data on the candidate's lesson and assistance to strategize how to improve performance for the next lesson.

3. **Data-Driven Feedback** contains collected measurable statistics from an observation that is provided to an educator about a particular performance. These observations can be gathered by an administrator, observer, or some other type of mentor using a data collection tool (Boody, 2008).
4. **Bloom's Taxonomy** (Anderson & Krathwohl, 2001; Bloom, 1956) is a hierarchical set of concepts used to express the level of expertise required to achieve a measurable outcome. In Bloom's (1956) original taxonomy, outcomes included basic knowledge, comprehension, application, analysis, synthesis, and evaluation. This scale begins with understanding of a subject and extends to higher-order thinking. For the current study, the research will be based in the original 1956 version of Bloom's Taxonomy.
5. **High-Leverage Practices** (Ball & Forzani, 2010) are skills an educator can use while teaching to positively effect student learning in the desired content area. These skills can include leading a group discussion, understanding how a student thinks about a concept, and using different types of questions to engage student learning. This research focused on the high-leverage practice of using different types of questions to engage student learning.
6. **Higher-Order Thinking (HOT)** is represented by the third through sixth levels of Bloom's Taxonomy (1956), application, analysis, synthesis and evaluation. When HOT concepts are applied to questioning strategies, the questions do not have simple

responses and require abstract thinking. HOT questions can be open-ended and have many correct answers or interpretations (Geertsen, 2003).

7. **Knowledge/Comprehension (K/C)** involves a level of thinking included in the first two levels of Bloom's Taxonomy (1956), basic knowledge and comprehension (K/C). K/C questions will often have direct answers, referencing information that was learned previously (Geertsen, 2003).
8. A **Preservice Teacher** is an individual who is studying to be a teacher within the pre-K-to-12 school setting. Each completes a set of courses regarding content knowledge and pedagogical knowledge in a teacher-preparatory program (CAEP, 2014). In this study, preservice teachers are also referred to as participants or candidates.
9. **Mixed-Reality Simulation** (provided in this study by Mursion, also known as TeachLivE) uses a mixed-reality or augmented-reality teaching environment supporting teacher practice in classroom management, pedagogy, and content. It uses videogame-based graphical images and support from experts to create a classroom or other education-related scenarios (Mursion, 2015).
10. **Self-Efficacy** refers to one's belief in one's own ability to perform actions or make choices that exercise influence over events that affect one's life (Bandura, 1994).

Methodology

The research questions used to guide this study are:

Research Questions

1. Is there a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores

for the number and types of questions they asked while teaching lessons and the other does not?

Non-directional Hypothesis: There is a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores for the number and types of questions they asked while teaching lessons and the other does not.

2. Is there a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not?

   Non-directional Hypothesis: There is a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not.

3. What are the perceptions of preservice teachers' abilities and experiences in using a mixed-reality simulation where one group receives data-driven feedback and coaching throughout a semester about their performance scores for the number and types of questions they ask while teaching lessons and the other does not?

Description of the Setting and Participants

The study was conducted at a southern New England state university. This university has a population of 5,826 current students. Of that number, 528 are at the graduate level while the remaining 5,298 are undergraduate. Eighty-five percent of the student body were in-state

residents. The group of students studied in this research were undergraduate students in the school's preservice teacher-preparatory program. The school of education, where this study took place, had 145 students. The education program is accredited by The National Council for Accreditation of Teacher Education (NCATE, 2015). Students who were in the preservice teacher-preparatory program, with few exceptions, had finished their main classes as connected to their content areas and were taking classes within the realm of education during the time of this study. The grade levels for which the candidates were preparing to teach ranged from elementary to secondary. The two groups in this study were divided into two course sections and each section contained 14 to 17 students. These were two sections of the same preservice teaching course, a mix of sophomores and juniors, who were scheduled to teach three lessons in a mixed-reality environment as part of the academic program. The course was Educational Psychology II: Childhood and Adolescence (refer to Appendix A for course syllabus and Appendix B for mixed-reality simulation sessions rubric). This was either the third or fourth educational course for these preservice teachers.

Research Design

This research study used a mixed-methods embedded design in which quantitative data (quasi-experimental) were the main component for study (Creswell & Clark, 2011). In the spring of 2017, data were collected from one course section of students that served as the treatment group and one section that was designated as the comparison group. Course sections were randomly assigned to either treatment or comparison condition. Both treatment and comparison groups completed Tschannen-Moran and Hoy's Teachers' Sense of Efficacy Scale (2001) at the beginning of the semester and after their final mixed-reality simulation session. All students in both sections were at similar points in their college-class completion and the same

professor taught both sections. Each class of preservice teaching students taught three 10-minute sessions within the mixed-reality simulation. These sessions were distributed throughout the semester. Individuals in the treatment group received data-driven feedback from the researcher about the number and types of questions they asked in the prior teaching session, including sessions from the prior semester, and were coached to form a plan to improve their higher-order questioning techniques for subsequent lessons. At the end of the semester the comparison group also received a report of their use of questions in each of the mixed-reality simulation sessions. A final telephone interview was conducted with each member of the treatment and the comparison groups to ascertain their perceptions of participation in the mixed-reality sessions.

Instrumentation

Student demographic survey. Basic demographic data were collected from a questionnaire and from student transcripts. The type of information collected from the students was age, racial or ethnic status, gender, content area major, current employment, grade level in college, GPA, and grades in prior education courses.

Classroom Practices Record (CPR; Westberg, Archambault, Dobyns, & Salvin, 1993). This instrument was originally created "to document the differentiated instruction that gifted and talented students receive through modifications in curricular activities, materials, and verbal interactions between teachers and students" (p. 81). In its original design, the CRP contains six core sections of measurement, which include Identification of targeted students, Information about the students, Physical Environment Inventory of the Classroom, Curricular Activities included in the observed lesson, Verbal Interactions during the observed lesson, Teacher Interview Record, and Daily Summary of the observation. In this study, this instrument was

used to collect data on the amount of HOT and Knowledge/Comprehension (K/C) questions generated in each of the observed lessons for all interactions.

Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Hoy, 2001). The TSES is divided into three subscales: efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management. At the beginning and end of the study, both the treatment and the control groups completed the survey. The survey has 24 items, the responses are recorded on a 9-point Likert scale, and the time of completion is five to 10 minutes. Further material about validity and reliability are in included in Chapter 3.

Participant interview. When all three mixed-reality simulation sessions were completed, each participant in the treatment group and the comparison group were interviewed to gauge how the process with the mixed-reality simulation was perceived. These interviews were digitally recorded over the telephone. The questions addressed their perceptions about the simulator, the questioning feedback, their performance, and suggestions for the future (see Appendix C for questions). Each interview lasted between 15 and 25 minutes.

Limitations of the Study

In the quantitative portion of this mixed-methods model a quasi-experimental design using intact groups was employed. There are several limitations inherent in this design as well as in the nature of the particular research. Although each student was not randomly assigned to either a treatment or comparison group, the course sections studied were randomly assigned to either condition. For the treatment to be effective, each coaching or feedback session needed to be conducted within two to three days after each mixed-reality simulation session. This practice was maintained throughout the study. Although generalizability of the results can only be

applied to this particular sample, the design could be replicated if the study was carefully implemented in another location as it is described in the report of the findings.

CHAPTER TWO: REVIEW OF LITERATURE

This mixed methods study was designed to examine questioning skills generated from preservice teacher's using a mixed-reality simulation in a teacher-preparatory program. Their performance, self-efficacy, coach and preservice teacher interactions, and preservice teacher perceptions are all variables under consideration for this research. This review of the literature has been provided to support the purpose of the study. The chapter has been divided into the following sections: (a) An Explanation of the Literature Review Process, (b) Self-Efficacy Theory, (c) Self-Efficacy and Teacher Reflection, (d) Reflection in Teacher Coaching, (e) Computer Simulation in Education, (f) Simulation in Teacher Education, (g) and Chapter Summary.

Literature-Review Process

The main source for this review of the literature came from searching through online data bases. These resources included the Education Resource Information Center (ERIC), Education Research Complete, EBSCO combined data base, JSTOR, the university's physical library, and e-book selection. When searching for research in areas of interest, the researcher used only peer-reviewed articles.

The researcher started with an area of interest "preservice teacher self-efficacy." That term produced 489 results. The researcher narrowed the search by limiting the articles to only the past 15 years and added terms to help refine the process and used the search term "preservice teacher self-efficacy perceptions." This yielded 49 references. When the researcher received results under 80 to 100 articles he reviewed titles and abstracts of the listed findings and selected articles pertinent to the focus of the study. When searching for teacher reflection connected to self-efficacy the search term "self-efficacy teacher reflection" resulted in 71 articles. Next, the

researcher explored research regarding reflection practices in preservice teacher coaching, the term "reflection preservice teacher coaching" revealed only 3 articles. Upon review, the articles were not applicable to the study. The researcher widened the search term to "reflection teacher coaching" which yielded 79 articles. For the final two sections of this chapter the researcher wanted to explore simulations used as a teaching tool and mixed-reality simulations. The term, "computer simulation in education" resulted in 1007 articles. To filter this to studies where an educator is directly using a simulation as a teaching tool the term "computer simulation used in education" yielded 49 articles. Lastly, in searching for articles pertaining to mixed-reality simulations the researcher used two search terms to find articles of interest. The first was "mixed reality simulation" that resulted in 70 articles and "TeachLivE," the original name of the simulator system being used in this study (now named Mursion) that resulted in 53 articles. Reviewing all abstracts of the listed findings resulted in 18 references used in this review of the literature. Articles were also found within the researched sources. This added three references to the review presented here, resulting in the inclusion of 21 peer-reviewed studies. Each area of the literature that is reviewed is preceded by a table highlighting information from the selected studies.

Self-Efficacy Theory

The types of feedback one receives about individual actions preformed can impact personal growth in mastering a skill or making decisions (Bandura, 1986). This idea falls under social cognitive theory (Bandura, 1986), the major construct of which is known as self-efficacy. Self-efficacy is the level of certainty in one's individual ability to perform an action or make decisions and achieve the desired results. According to Bandura (1986, 1994, 1997), there are four dimensions to developing one's self efficacy, including the mastery of experiences, one's

secondhand (vicarious) experience, amount or type of social encouragement received, and how the individual responds to stressors.

The most effective method to gain self-efficacy in a task or discipline is mastery of experiences (Bandura, 1994). Having a direct experience in completing a task or controlling an environment will build self-belief in completing that undertaking. However, there are outcomes that could undermine one's growth in developing self-efficacy. Bandura stated, "if people experience only easy successes they come to expect quick results and are easily discouraged by failure. A resilient sense of efficacy requires experience in overcoming obstacles through perseverant effort" (1994, p. 3). To effectively gain self-efficacy through mastery of experiences required a balance between experiencing success and overcoming obstacles.

Secondhand (or vicarious) experiences can bolster self-efficacy by observing the outcomes of others and relating those outcomes to oneself. Bandura noted, "seeing people similar to oneself succeed by sustained effort raises observers' beliefs that they too possess the capabilities to master comparable activities" (1994, p. 4). Conversely, if an individual sees someone fail, despite a good effort given, then that could lower an individual's self-efficacy toward a similar undertaking.

Social encouragement comes from the individuals with whom one interacts. It provides a social norm an individual can use to understand and judge his or her own capabilities. Bandura stated, "people seek proficient models who possess the competencies to which they aspire. Observer's effective skills and strategies for managing environmental demands" (1994, p. 9). The final dimension of Bandura's theory relates to an individual's response to stressors. Bandura (1994) stated, "People's beliefs in their coping capabilities affect how much stress and depression they experience in threatening or difficult situations, as well as their level of

motivation" (p. 7). If a person believes that he or she is strong enough to handle a stressful situation then that individual is more likely to react in a reasonable way when engaging in the stressful activity.

Self-Efficacy in Preservice Teachers

The researcher wanted to better understand self-efficacy research in regard to preservice teachers. This exploration provided insight into how self-efficacy is studied and measured with respect to teacher education programs. This investigation of the literature gave guidance for a deeper focus on participant characteristics and outcomes. In Table 1, studies were gathered that had relevant subject matter such as, growing teacher skills, preservice teacher training, and preservice teachers' perceptions of the preparatory programs they were in.

Table 1

Self-Efficacy Studies About Preservice Teachers

Topic/Authors	Participants	Purpose	Findings
Self-efficacy and team work; Velthuis, Fisser, and Pieters (2015)	Two teachers and one preservice teacher (n = 3)	A case study was conducted to understand whether or not participation in a teacher design team was an effective way to increase self-efficacy for teaching science.	Collaboration in a team appears to improve levels of teachers' self-efficacy regarding teaching science.
Self-efficacy toward teaching content; Hong-Nam and Szabo (2011)	(n = 155) junior year K-6 preservice teachers	The researchers explored K-6 preservice teachers' attitudes towards teaching content literacy strategies.	Student teaching efficacy scores were higher after literacy strategies intergraded into training courses (pre-M = 3.61, post-M = 4.26, p = .000).
Self-efficacy and perceptions of satisfaction; Chesnut and Cullen (2014)	College juniors and seniors at a university in the American southwest (n = 209)	The research was used to examine expectations about the future work environment, perceptions of satisfaction, self-efficacy, and emotional intelligence of preservice teachers.	Self-efficacy, perceived satisfaction with expectations about the future work environment, and emotional intelligence predicted significant factors for commitment to the field of education (r = .35, p < .01).
Personality and preservice teacher self-efficacy; Jamil, Downer, and Pianta (2012)	Preservice teachers from four cohorts (2007-11) attending an east coast state university (n = 509)	The researchers explored a teachers' underlying psychological attributes of personality and beliefs regarding preservice teacher self-efficacy.	Preservice teachers who were aligned with student-centered learning reported higher self-efficacy, while whose who were not student-centered reported lower self-efficacy.

Self-efficacy and team work. A teacher's self-efficacy can affect how he or she plans a lesson or curriculum unit. In 2014, a study was conducted in the Netherlands to investigate participation in a teacher design team as an effective way to increase the science teaching self-efficacy of primary school teachers who vary in their levels of experience and interest in science (Velthuis, Fisser, & Pieters, 2015). During the time of this study the Netherlands was suffering from a shortage of qualified science teachers for their primary schools. Thus, many nonscience teachers had to take on the task of integrating some of the science content into the curriculum. The study was conducted in a case study format that had three teachers of varying levels of science background. Teacher 1 had a strong science background, teacher 2 had very little interest in science, and teacher 3 was a preservice teacher who was interested in science but had little background and no teaching experience. At the start of the school year, each member of the study was given a self-efficacy pre-survey (1 = lowest and 5 = highest) regarding teaching science content. The scores were recorded: Teacher 1 = 4.00, Teacher 2 = 3.08, and the preservice teacher = 3.33.

With the start of the school year, each teacher became a member of a Teacher Design Team (TDT). All three members of the study were part of the same team, along with two science teachers and an administrator. The whole design process was carried out in eight meetings of approximately two hours each. The assignment of the team was to redesign science curriculum for students from 4 to12 years old (Velthuis, Fisser, & Pieters, 2015). In working in a TDT the hope was to increase the participants' self-efficacy regarding teaching science content by having them create science curriculum alongside members of a team who were considered to be experts. After completing half of the TDT meetings, a midpoint-survey was given (Teacher 1 = 4.09, Teacher 2 = 3.50, and the preservice teacher = 3.67).

At the end of the eighth week of TDT meetings, a post-survey was given (Teacher 1 = 4.64, Teacher 2 = 3.83, and the preservice teacher = 3.30). Both Teachers 1 and 2 made progressive increases in their self-efficacy toward teaching science content. However, the preservice teacher regressed back to the original score at the time of the pre-survey. In an interview with the preservice teacher, she stated the only teaching experience she had up to that point was science activities in small groups, but she wanted to learn how to teach science with all children at the same time. Velthuis, Fisser, and Pieters (2015) concluded that, "collaboration in a TDT seems to be a way to improve levels of teachers' self-efficacy regarding teaching science content with varying degrees of experience and interest in science" (p. 224). When experienced teachers discuss and share their teaching strategies with others their self-efficacy appears to increase, while those who have low experience may feel intimidated by the complexity of the task and need more coaching and experience to boost their confidence.

Self-efficacy toward teaching content. In 2011 at a Texas university, a study was conducted with 155 junior year K-6 preservice teachers who reported their attitudes about being able to include reading skills in content areas. This study was preformed was because little was known about K-6 preservice teachers' attitudes towards teaching content literacy strategies and the application of those strategies (Hong-Nam & Szabo, 2011). Another rationale for conducting the study was that preservice teachers may experience personal resistance in implementing literacy strategies in content areas if they do not believe in their usefulness or feel confident in using the strategies (O'Brien, Stewart, & Moje, 1995). One outcome of low self-efficacy in teaching is that a preservice teacher might be familiar with a wide variety of strategies, however might only implement a few when teaching.

Quantitative survey data were collected in this study, and the instrument examined the pre-post attitudes and confidence in reading skills strategies of the participants. The pretest was administered during a seminar class in the second week of a fall semester while the posttest was administered during the last week of the same year, during the spring semester. During the academic year the preservice teaching program integrated a variety of literacy strategies into training courses. This included built-in seminars and time for using learned strategies within real lessons. Hong-Nam & Szabo (2011) found, "the over-all mean scores at the end of the year-long student teaching experience were higher (pre- $M = 3.61$, post- $M = 4.26$) and the t-test showed that the change was significant ($t = -5.92$, $p = .000$)" (p. 128). This study, focusing only on preservice teachers, combined a structured integration of teaching strategies and experience in implementing the strategies, which resulted in a significant increase in self-efficacy.

Self-efficacy and perceptions of satisfaction. A 2014 study investigated the effects of expectations of future work environment, perceptions of satisfaction, self-efficacy, and emotional intelligence on preservice teacher commitment to the profession (Chesnut & Cullen, 2014). Expectations of future work environment involve one's salary, the workload and hours, autonomy in the classroom, collegiality, and administrative support. Perceptions of satisfaction connected to one's view of what in the profession makes them satisfied. Lastly, emotional intelligence addresses an individual's psychological wellbeing in handling stressful situations for productive outcomes.

Chesnut and Cullen stated, "maintaining commitment to the teacher education program and eventually entering the teaching profession requires a positive outlook and the ability to adapt to changing environments and stress levels" (2014, p. 119). Data collection for the study was conducted using a custom (collected parts of other instruments) one-time online survey of

209 college juniors and seniors at a university in the American southwest. The survey used Likert-type questions. For example, one of the Likert-scale items used to measure "expectations of autonomy" was: "As a teacher, I will have the freedom to make the instruction for the classes that I am teaching" (Chesnut & Cullen, 2014, p. 122). Chesnut and Cullen found that self-efficacy, emotional intelligence, and perceived satisfaction with expectations of future work environment accounted for 3.53%, 10.43%, and 2.25% of the variance, respectively, in predicting commitment ($r = .35$, $p < .01$). This is important because the experience of the preservice teacher is multifaceted and many components need to be considered when implementing a teacher-preparatory program.

Personality and preservice teacher self-efficacy. Low self-efficacy in preservice teachers may attribute to high attrition rates among early career teachers (Jamil, Downer, & Pianta, 2012). In 2011, a study was conducted to explore a teachers' underlying psychological attributes of personality and beliefs regarding preservice teacher self-efficacy. In addressing these issues Jamil et al. explained, "not achieving mastery on a task can lead to lowered self-efficacy and future expectations of failure" (2012, p. 121). Five hundred nine preservice teachers were drawn from four cohorts (2007 to 2011) in an east-coast state university. All participants were in the final year of a teacher-education preparatory program. Data were being collected for a larger study of which this research was a satellite. Self-efficacy and performance surveys were administered during the student-teaching placement process, and again in the last semester of the teacher-preparation program, when the preservice teachers completed exit surveys.

As part of the teacher-preparation process, preservice teachers learned about the importance of developmental-orientation (e.g., student-centered learning, inquiry) for student

success. The participants whose own notions aligned well with a developmental approach held a belief that a teacher has the ability to support a students' social and academic growth, thus resulting in successful performance and increased self-efficacy. Conversely, preservice teachers who were not engaged in student-centered learning, such as inquiry, needed more guidance and experience than their peers to gain the necessary skills for delivering classroom instruction resulting in student success. Jamil et al. suggested, "pre-service teachers need opportunities to receive accurate, yet constructive feedback about their teaching performance during field placements in order to make well-balanced judgments about effective and less effective teaching moments" (2012, p. 133). This conclusion supported the idea that providing direct and detailed feedback and coaching for preservice teachers can grow their skills.

Self-Efficacy and Teacher Reflection

Self-reflection is one of the most uniquely human capabilities (Boody, 2008). For this form of self-referent thought, people can evaluate their actions to alter their own thinking and behavior (Bandura, 1986). Bandura has explained that self-evaluations include perceptions of self-efficacy (1994). These beliefs of personal competence affect behavior in several ways. They influence the choices individuals make and the courses of action they pursue. Reflection is dependent on one's level of known information and the reconciliation of information with evidence (Boody, 2008). For a teacher, reflection can have either a positive or negative consequence. In a positive situation, reflection can be used to reinforce learning and draw attention to factors that need to be changed in the future. On the other hand, reflection can result in critical information being disregarded or it may reinforce misconceptions that have been learned as fact. These examples mirror the issues explained by Bandura (1994) about how one's self-efficacy is affected by positive and negative interactions.

Positive outcomes of reflection are seen in improvements made in thoughts and actions. An issue commonly encountered is facing a task that feels overwhelming or aggravating in such a way that an individual ultimately does little to improve the situation. Another obstacle to learning is complacency, wherein one may perform a task in a certain manner over time that an individual becomes comfortable with the performance and, subsequently, never challenges, improves upon, or seeks alternative methods of completion. These issues can be identified and solutions can begin to be developed when one engages in some type of reflective process. For teachers, the complex decision-making world of the classroom can seem immensely frustrating when trying to focus on self-improvement. Having a good foundation in reflection can be a powerful tool to engage in improvement. Reflection begins with having the knowledge to understand actions, routines, and habits in the teaching practice (Boody, 2008). Reflection also needs to occur throughout the performance of a task, before, during, and after initiation of an activity (Boody, 2008).

A Review of Self-Efficacy and Teacher Reflection

Because the current research relies heavily on how a preservice teacher reflects on his or her performance, the researcher conducted a review of the literature of studies that focused on connections between teacher reflection, self-efficacy, and preservice or novice teachers. In Table 2, studies relate to reflective practices, the reflective process on instruction, and perceptions of preservice or novice teachers in using these reflective skills.

Table 2

Self-Efficacy and Teacher Reflection Research Studies

Topic/Authors	Participants	Purpose	Findings
Comparing self-efficacy of preservice teachers with self-reflection; Brannon and Fiene (2010)	Student teachers in an Illinois teacher-preparatory program (n = 41)	The researchers compared self-efficacy of preservice teachers who were rated as distinguished or proficient in their performance.	Distinguished students felt that they were significantly more effective in many areas than proficient student teachers.
Teacher reflection and the reflective process; Laverick (2016)	Sixth-to-twelfth grade educators (n = 5)	An exploratory study was conducted to understand teacher reflection and how a reflective process is implemented within instruction.	Participants must be held accountable for engaging with the reflective material either through direct instruction or the implementation of a tracking system.
Reflection in in-service teacher development; Kayapinar (2016)	Internationally certified teachers with 1 to 5 years of English teaching experience (n = 45)	The researcher studied a reflective practitioner development model for an in-service program	Mean (80.13) TSES scores from the second-round survey were significantly higher than those from the first-round (M = 69.53, p = .007).
Reflections of preservice teachers' insights into personal learning; Blackley et al. (2017)	Female teacher education students (n = 9) and schoolgirls in fifth and sixth grades (n = 71)	The researchers explored the progress and reflections of Australian preservice teachers' insights into their personal learning and development as teachers	Participants used reflective practices to successfully overcome concerns and setbacks. All preservice teachers reported finding the project valuable and expressed enjoyment in participating
Preservice teachers' reflections on technology experiences; Blackley and Walker (2017)	Preservice teachers from a 2014 and 2015 cohort (n = 33)	This study examined preservice teachers' reflections on their experiences with 1:1 laptop programs regarding the consideration of aspirational teaching practices.	Reflections to help recognize effective usage of technology in the classroom and identify areas of growth needed in a teacher-preparatory program.

Comparing self-efficacy with self-reflection. The ability to reflect on one's actions is a prime way to understand shortcomings and plan strategies for improvement. In 2008, a study was conducted to compare self-efficacy scores of 41 student teachers in an Illinois teacher-preparatory program who completed reflections and were rated as distinguished, proficient, or unsuccessful in their student-teaching performance (Brannon & Fiene, 2010). The researchers used these three qualities to rate participants' level of growth throughout the student teaching process. A rating of distinguished meant that the participant showed major growth in classroom skills and proficient meant they showed positive growth in classroom skills. One can be unsuccessful for several reasons, such as a participant who did not display growth or lacked skills to proceed in the program. Study participants kept a graded reflective journal throughout the process. Brannon and Fiene (2010) stated:

> Reflective journals are often used in education programs by preservice teachers as tools to study their practice. Reflective journals are excellent learning tools for students studying to be teachers. They provide valuable data that can be utilized for professional development during preservice field work and student teaching. (p. 89)

Most participants in the study were rated as proficient. Regarding reflections, the proficient student teachers addressed thoughts on technical level subjects, such as classroom management issues and lesson sequence. Although these were valid reflections, they lacked deep insight into personal practice. The few student teachers who were ranked as distinguished also focused on technical level subjects but demonstrated more thoughtful and complex reflections. The distinguished student teachers were also able to analyze their teaching, make revisions accordingly, and then implement change.

When connecting reflection to a teacher's self-efficacy one must consider classroom-management skills, organization, teaching, classroom activities, effort, and the ability to motivate students and communicate effectively (Brannon & Fiene, 2010). At the end of student teaching the participants completed a self-efficacy survey. Data from the survey, in combination with the reflective journals, revealed both the proficient and distinguished groups of student teachers experienced success during student teaching. However, as Brannon & Fiene (2010) found,

> Distinguished students felt that they were significantly more effective in many areas than proficient student teachers . . . distinguished student teachers rated themselves significantly more successful at getting through to the most difficult students, helping students think critically, fostering creativity, and helping students value learning. (p. 94)

Although these reflective journals were kept throughout the study, there was no information regarding when reflections were recorded with respect to a teaching event. There was no information to indicate reflections before, during, or after instruction.

Teacher reflection and the reflective process. In 2016, an exploratory study was conducted with five sixth-to-twelfth grade educators in a county in Ohio to understand teacher reflection and how a reflective process was implemented within instruction (Laverick, 2016). Another point of interest in this study was finding connections between reflective processes and evaluating teachers. The researcher used a form of reflection known as the meaning-making process. Laverick (2016) explained meaning-making as a "process that moves a learner from one experience into the next with deeper understanding of its relationships with and connections to other experiences and ideas" (p. 58). For example, a teacher analyzed what happened in a class to decide what he or she could do better and used that knowledge to inform future instructive decisions. During the start of the fall semester all participants took an online survey

that inquired how often individuals reflected on personal teaching moments. In addition, open-ended questions were used to find out how participants reflected upon teaching moments and how those reflections were used.

During the school year, the five teachers were given an online Google drive with materials to help teachers become more reflective. Usage of the documents was not tracked and participant usage of the materials was entirely voluntarily. The same survey about reflection on personal teaching moments was administered at the end of the spring semester, in addition to interviews. The participants had a limited understanding of reflection. This was present in both the pre-and post-surveys but did not necessarily mean participants had no engagement in reflection. All five teachers responded to survey statements such as, "looking back at your lesson/unit and deciding what went well and what could use more work for improvement" (Laverick, 2016, p. 61). However, comments explaining reflective practices did not appear. This could be due to the lack of interaction between the teachers and the provided material or the fact that there was no direct instruction given to the participants regarding reflection. As such, Laverick acknowledged, "the teachers did not describe their reflective practices nor explain inquiry and community, they may have missed out on potential areas for further growth" (2016, p. 64). This study provided two major recommendations, the first of which was to increase the size of the study. The second recommendation was that participants must be held accountable for engaging with the material either through direct instruction or the implementation of a tracking system. Laverick concluded, "enhanced reflective opportunities . . . could grow and develop the reflective capabilities of their staff" (2016, p. 65). Growing the skills of preservice teachers using reflective practices through feedback and coaching is a main goal of this research.

Developing a reflective practitioner. A study was conducted to implement an English as a foreign language (EFL) reflective-practitioner development model for an in-service program, as well as to measure teachers' reflective and self-efficacy development (Kayapinar, 2016). Middle Eastern students in EFL programs complained about their teachers' poor performances. Kayapinar (2016) believed implementing reflective practices to in-service teachers could remedy this, and stated, "reflection enables teachers to make careful considerations about what their experiences are and to form a habit of continually learning from their own experiences by framing problems of practice" (p. 1672). The study was performed with a group consisting of 45 randomly assigned, internationally certified teachers with one to five years of English-teaching experience. Over the course of a semester the participants engaged in professional-development sessions, wrote reflective observations about individual teaching practices, received feedback from peers, and held focus-group discussions to grow the reflective practice. The participants also took the Teachers' Sense of Efficacy Scale (TSES) before and after the semester.

Kayapinar (2016) wanted to use the TSES regarding reflection because "one's self-efficacy belief is a powerful tool for teachers to manage and control power so that their teaching practice may be effective, and thereby facilitate their students' learning" (p. 1676). Initially, participants in the study noted that class problems were always caused by outside sources; and did not reflect critically or question personal involvement to solve problems encountered in the classroom environment. After attending professional-development sessions and receiving peer feedback, the educators took a teacher-centered view toward language education. Kayapinar noted this change in attitude can also be seen in the TSES scores, "the mean score (80.13) of the second round was higher than that (69.53) of the first round. This was also backed up by the

correlation analysis ($p = .007$)" (2016, p. 1688). These findings support the integration of a reflective practitioner model into a professional development program for teachers.

Preservice teachers reflect on pedagogical practices. Over the last several years, school personnel have been offering students more engaging experiences in the Science, Technology, Engineering, and Mathematics (STEM) fields. One method of giving school children these experiences is through the concept of the makerspace. A makerspace is usually a designated area where students can participate in hands-on activities such as 3-D printing, electronics construction, or computer programming. In 2016, an exploratory study was conducted on the progress and reflections of Australian preservice teachers' insights into their personal learning and development as teachers, regarding STEM and using makerspaces (Blackley et al., 2017). The participants were nine female teacher-education students and 71 females in fifth and sixth grades. Blackley et al. (2017) acknowledged the need for this study by stating, "preservice teachers' reluctance to engage with science and mathematics [and concluding] there is a need to provide additional opportunities for them to develop skills and positive dispositions in the STEM space" (p. 23). An exploratory case study was employed to examine participant engagement with and reflections on a single, makerspace STEM project. The participants were placed into two groups. Preservice teacher participants were given the task to apply and reflect on the science and technology pedagogical practices that would support students to develop an increased understanding of STEM concepts. Whereas, students of the preservice teachers were given the task of creating an electronic origami light-up flower. Focus-group interviews were conducted with the students, whereas individual interviews were conducted with the preservice teachers at multiple times during the study. Additionally, the creative products of both preservice teachers and students were collected. When creating the

electronic flower, both the preservice teachers and students had difficulties with the instructions and reported high levels of frustration. However, this became a reflective moment for the researchers and the educators. A robust conversation was had about addressing issues with the instructions and how to supplement them (Blackley et al., 2017). Throughout the study, the participants used reflective practices to successfully overcome concerns and setbacks. All preservice teachers in the study reported finding the project to be valuable and expressed enjoyment in participating, despite the challenges. The students also displayed positive attitudes toward the project. Blackley et al. (2017) determined that a reflective, "approach enables [preservice teachers] to develop their confidence and competence in STEM education" (p. 34). Increased self-efficacy should be a goal for teachers across content areas.

Preservice teachers use reflective practices for skill building. One to one (1:1) device programs are becoming more prevalent in school systems across the world. These programs provide each student in a school with a device (laptop, or other internet connected device) for completing assignments, accessing class content, and connecting to the Internet. In 2015, a study was conducted in an Australian teacher-preparatory program that examined preservice teachers' reflections on their experiences with 1:1 laptop programs regarding the consideration of aspirational teaching practices (Blackley & Walker (2017). Blackley and Walker incorporated teacher reflections into their study and explained, "given the expenditure of time and money to successfully launch and maintain 1:1 laptop initiatives, investigation needs to be carried out to determine if the commitment has been worthwhile" (p. 2). The participants in this study were placed into two groups; 23 preservice teachers from a 2014 cohort and 10 preservice teachers from a 2015 cohort. After the participants finished the student-teaching semester, each completed an anonymous online survey that contained both demographic and reflective

components. A reflective survey included a five-point Likert scale that asked questions regarding the value of 1:1 programs and their usefulness in classroom environments. Seven participants across both cohorts volunteered to be interviewed. These interviews "collected extended opinion and attitudinal data, as the participants were encouraged to reflect on their past experience and also to project themselves into their profession" (Blackley & Walker, 2017, p. 4). When analyzing the participants' reflections, a common theme began to emerge. The preservice teachers expressed a lack of skill related to managing student use of technology in the classroom. Although the laptops were a powerful information tool, the classroom-management issues that participants had with students were problematic. Due to this finding, Blackley and Walker suggested that, "to prepare preservice teachers to effectively and authentically integrate technology into student learning . . . strategies must be incorporated into initial teacher education programs" (2017, p. 11). Teacher reflections are used for self-improvement and, in this case, participants could use these reflections to help recognize effective usage of technology in the classroom. However, in the case of the current study, reflections were also used to help identify areas of growth needed in a teacher-preparatory program.

Reflection in Teacher Coaching

Reflection among teachers typically falls into one of four categories: reflection as retrospection, reflection as problem solving, critical reflection, or reflection-in-action (Boody, 2008). Reflecting as retrospection is a common practice that one can engage in for any aspect of life. For example, one may look back on movies enjoyed as a child, teenager, young adult, and later as an adult, and consider the factors that influenced various likes and dislikes. Boody stated this approach to reflection requires reconsidering and learning from prior experiences. This is an approach that can be utilized in the field of education as the idea of deep and thoughtful

consideration is important to becoming a better teacher (Boody, 2008). Reflection as problem solving allows an individual to place oneself in a prior event to think about how a situation might have been handled differently. When a similar experience happens again individuals can adjust accordingly, having reflected upon a similar situation previously. After an event occurs, post reflection is also important to gauge improvement (Boody, 2008).

Critical reflection, according to Boody is, "exploring what is most educationally worthwhile and creating the conditions that would allow all people to equally join in the dialogue on what is of most worth" (2008, p. 501). This style of reflection focuses on the educator's actions in addition to the work system as a whole. Policies, rubrics, administrative goals, community members, and many other factors impact reflection on system thinking, which are used to gain a greater understanding of actions taken and to aid in implementing improvements. Whereas reflection-in-action occurs during a current event or situation, in a time where one may change the outcome in a meaningful way, in-the-moment reflection-in-action can be challenging for new teachers due to lack of experience. Boody acknowledges, "reflection-in-action may seem unconscious, actions going on under the surface . . . however many professionals' activities would include time for a reflection-in-action that are conscious. The action-present could be just seconds for a baseball pitcher" (2008, p. 502).

In any profession, feedback from a mentor, expert, or coach is crucial in gauging where one currently stands, and how one might improve (Reagan, Case, & Brubacher, 2000). Feedback, in education, occurs in many forms. Teachers use student scores as a measure of how well individuals in a classroom are doing' and can use state test scores to gauge how a class compares to a larger group of students. Administrators give feedback to teachers using data-driven rubrics to measure classroom interaction, personal observation, or a combination of both

(Blazar & Kraft, 2015). Coaching and data-driven feedback should be used to influence reflective practice.

Review of Reflection in Teacher Coaching Literature

The path for a preservice teacher to become a reflective practitioner is a major aspect of teacher education. How it happens requires a thoughtful level of guidance. In order to explain the complex nature of teaching reflective strategies, this researcher conducted a review of the literature about use of reflective practices for coaching in-service and preservice teachers. In Table 3, studies were selected that had relevant content such as, teachers' coaching methods, coaching with a reflective process, coaching connected to self-efficacy, data-driven coaching, and coaching of preservice or novice teachers.

Table 3

Teacher and Preservice Coaching Research Studies

Topic/Authors	Participants	Purpose	Findings
Comparing two professional development models; Stichter, Lewis, Richter, Johnson, and Bradley (2006)	Sixteen teachers and 16 targeted students across two elementary schools in a large Midwestern city in the United States (*n* = 32)	This research compared two separate professional development models. Traditional in-service professional development was compared to peer coaching.	Peer coaching showed implications of positive changes associated to teaching outcomes connected to academic success.
Coaching elementary classroom and teaching science content; Berg and Mensah (2014)	First-grade teachers from a large urban district in the northeast United States (*n* = 3)	The researchers explored how coaching addressed elementary classroom educators' perceived dilemmas in teaching science content.	After the interventions, all participants felt the content was manageable and, with time, could be mastered for the students at the grade-level taught.

(continued)

Table 3

Teacher and Preservice Coaching Research Studies

Topic/Authors	Participants	Purpose	Findings
Match Teacher Coaching in charter schools; Kraft and Blazar (2013)	New Orleans K-12 teachers (n = 59)	The research was used to explore the effectiveness of Match Teacher Coaching (MTC) in charter school teachers.	Treatment group teachers were rated more effective (p = .04) than those who participated in the standard professional development activities provided (p = .56).
Using data to coach a fifth-grade teacher; Berg and Mensah (2014)	Fifth grade teacher (n = 1)	Case study to explore improving the use of Higher-order Thinking (HOT) questions in a school environment.	Final observation revealed that there was a significant change in the numbers and types of questions being asked in the classroom.
Preservice teachers using rehearsal and in-the-moment coaching; Averill, Drake, and Harvey (2013)	Preservice teachers in a New Zealand university (n = 44)	This study investigated perceptions of preservice teachers using rehearsal and in-the-moment coaching in a mathematics teacher education course.	Preservice teachers valued the realistic practice of teaching, as well as the immediate feedback received by the in-the-moment coaching.
Improving Questioning in the Classroom; Delcourt and McKinnon (2011)	Science Teachers (n = 11)	This study was conducted using the Classroom Practices Record (CPR) instrument as a tool in coaching educators in improving the ability to produce higher-order thinking (HOT) questions.	There was a significant change in the mean number of questions asked ($\chi^2 = 89.69$, $p < .01$). over time teachers designed more inquiry opportunities into their classes by creating inquiry-oriented activities.

(continued)

Table 3

Teacher and Preservice Coaching Research Studies

Topic/Authors	Participants	Purpose	Findings
Coaching methods to improve classroom management skills; Reinke, Stormont, Herman, and Newcomer (2014)	Elementary school teachers trained in classroom management intervention (n = 52)	The researchers investigated different coaching methods aimed at helping teachers improve classroom management skills.	All coaching seemed to have a positive impact, but coaching connected to data had a greater impact, $F(1, 50) = 52.57$, $p < .001$.
New teachers attending e-Coaching sessions and the effects on self-efficacy; Anthony, Gimbert, Fultz, and Parker (2011)	New mathematics teachers who completed a 6-week summer training in a Texas alternative certification program (n = 35)	The researchers investigated the outcome of new teachers who attended e-Coaching sessions and the effects on self-efficacy.	Teachers who attended 6 or more e-Coaching sessions reported gains in overall self-efficacy (Wilcoxon signed rank test, 2-tailed, $p = .075$) and instructional strategies efficacy (Wilcoxon signed rank test, 2-tailed, $p = .094$).

Traditional professional development versus peer coaching. A 2006 study was conducted to compare two separate professional development models, including traditional in-service professional development versus peer coaching. "One of the impetuses for simultaneously studying the peer coaching and the standard in-service models was based on the interest by the staff to initiate a peer coaching process" (Stichter et al., 2006, p. 676). In-service professional development, in this case lecture-based, in which teachers are taught about a subject in a large group. Peer coaching involves teachers who observe each other during periods of instruction and share performance feedback relative to a skill or concept that is being developed (Stichter et al., 2006). The targeted strategy for study was student opportunities to respond (OTR). Increasing OTR has demonstrated growth in learning among typically developing peers and those with mild disabilities (Stichter et al., 2006). The participants for this study were 16

teachers and 16 targeted students across two diverse elementary schools in a large Midwestern city in the United States. All teachers in the study completed two hours of professional development on OTR. Half of the teachers in the study attended an additional three-hour professional development on peer coaching (taking data, reporting to your peers, etc.). Direct observation data were collected over a 4-week period from all participants and their target students. Baseline data, taken at the start of the study, were compared to data gathered in the final days of the study. In analyzing the findings, teachers in the peer coaching group met 38% of the instructional goals and 81% made improvements across measured instructional strategies. Those who received traditional in-service professional development met 30% of the instructional goals and 68% made improvements across measured instructional strategies. However, Stichter et al. state, with respect to student performance, "despite unremarkable changes in directly observed and work product data, later literacy scores suggest that a majority of the students demonstrated academic growth" (2006, p. 685). More research is needed, because the small sample size of both the teachers and students in a singular school system limited the findings, the peer coaching showed implications of positive changes associated with teaching outcomes connected to academic success among students (Stichter et al., 2006).

Coaching educators' in teaching science content. In 2011, a case study was conducted to explore how coaching addressed elementary classroom educators' perceived dilemmas in teaching science content. Berg and Mensah (2014) stated, "elementary teachers have low confidence in teaching science. To cope, elementary teachers avoid teaching science, teach only the topics with which they are most comfortable" (p. 3). Unlike high school and middle school teachers, elementary teachers are responsible for teaching all the core subjects. They have

limited instructional time allotted to science, and consequently, many elementary school teachers have low confidence in teaching science.

Three first-grade teachers from a large urban district in the northeast United States, whom had previously disclosed reservations in teaching science content due to their lack of a science background, were chosen. Over the course of the 2010-2011 school year, all three participants voluntarily visited 12 science-based, professional-development sessions, agreed to be interviewed two times, and supplied the researchers with videorecordings of their science lessons. A supervisory science coach was assigned to meet with participants, plan lessons, and assist in some classroom science lessons. The coach also stepped-in during lessons to demonstrate certain strategies, or to respond to student questions when the participants requested assistance with the content (Berg & Mensah, 2014). Science kit-based materials also played a role in addressing the participants' apprehensions in teaching science. The activities in these kits have been designed to align with students' grade levels and were geared toward ease of use for the teacher. In the interviews, Berg and Mensah asked, "questions aimed at clarifying their dilemmas in teaching science, the reasons they ascribed to instructional changes…and if they improved" (2014, p. 8). All professional development meetings, interviews, coach sessions, and in-class science lessons were video- or audiorecorded and coded.

An inductive, multistage approach was used to analyze the data, while remaining open to ideas that surfaced from the data (Berg & Mensah, 2014). The first finding that emerged was that all participants found time for instruction to be their biggest constraint, in terms of teaching science. Participants had so many other school initiatives taking up instructional time, that it was hard to fit science planning into the day. Having the time designated for the coaching sessions and professional development had helped them with their planning-time dilemma. The second

finding related to the limited knowledge of science, with participants revealing a fear of teaching incorrect information to students. After the interventions, all participants felt the content was manageable and, with time, could be mastered for the students at the grade-level taught. The last finding was in implementation of science lessons, because each participant was unsure of how to create or instruct a science lesson.

After the interventions, that included the use of science-material kits, all three participants felt more confident; one went on to create her own science activities. Berg and Mensah (2014) acknowledged, because the "study was voluntary, the results achieved are believed to be less powerful than if the teachers had been required by their administrators" (p. 10). However, with effective support, coaching, and accountability, it may be possible to instill in teachers the need and motivation to expand their efforts. This study supported the use of coaching based on on-site observations.

Effectiveness of Match Teacher Coaching. Studies repeatedly find that professional development, as it is practiced in most public schools, does little to change teachers' classroom practices or improve student achievement (Kraft & Blazar, 2013). A 2011 study was conducted to explore the effectiveness of Match Teacher Coaching (MTC) in charter-school teachers in New Orleans. MTC focuses on improving classroom-management and instructional practices, with coaches observing live instruction and working in person with teachers to help improve individual practices (Kraft & Blazar, 2013). Key areas included in the coaching are behavior management, lesson planning, execution of lessons, student engagement, and classroom climate. Fifty-nine K-12 teachers were recruited for this study, "and among the final sample, teachers taught at 21 different schools operated by 13 charter management organizations" (p. 2). All study participants were early to midcareer teachers. All participating teachers attended a four-

day training workshop during the summer and then worked individually with an experienced coach, three weeks during the school year. Half of the participants were randomly placed into a treatment group that also received MTC once throughout every schedule rotation. In this group, the one-on-one coaches set rigorous expectations for teacher growth and evaluated progress through formative assessments on the MTC observation rubric (Kraft & Blazar, 2013).

Kraft & Blazar explained "observations [of] the effect of treatment [centered] on three main outcomes: an MTC observational instrument, a principal survey, and student survey" (2013, p. 3). In the findings for the MTC observational instrument treatment group, teachers were rated more effective than those who participated in the standard professional development activities. In the principals' survey, although treatment teachers were higher on a composite measure of overall effectiveness (.11 *sd*, $p = .56$), the difference was not significant. In the student survey, treatment teachers were rated higher (.28 *sd*, $p = .04$) than control teachers on the ability to challenge students with rigorous work. In addition, treatment participants self-reported large gains in organization over the comparison group (.49 *sd*, $p = .11$) in the MTC instrument survey, although this result was not significant. Kraft & Blazar determined "findings from this study, suggest that teacher coaching can enhance teachers' classroom practices dramatically. . . . Individualization makes coaching widely applicable to early and mid-career teachers across grades and subjects and suggests that coaching is a viable alternative to school-wide [professional development]" (2013, p. 5). Coaching sustained over time is supported as an effective strategy across a wide variety of contexts. All teachers, especially those training to be educators, should have the opportunity to be coached.

Using data-driven feedback in coaching a teacher. A study was conducted in 2011 that used the Classroom Practices Record (CPR) instrument as a tool in coaching educators in

improving the ability to produce higher-order thinking questions with 11 science teachers. Delcourt and McKinnon (2011) explained:

> The purpose of this activity is to influence student learning by improving the use of Higher-order Thinking (HOT) questions in a school environment. Ideally, both students and teachers should be using HOT skills on a regular basis through both questions and statements made during the school day. (p. 147)

CPR data were collected from a fifth-grade classroom. The data were used to create an improvement plan. The researchers then met with the teacher and coached her on how to utilize the improvement plan in her lessons. Next, the class was observed again to reassess, and finally the researchers met with the teacher to reflect on the experience. "As a result of the fifth-grade classroom study, a final observation revealed that there was a significant change in the numbers and types of questions being asked in the classroom" (Delcourt & McKinnon, 2011, p. 153).

Rehearsal and in-the-moment coaching. Averill, Drake, and Harvey (2013) examined the perceptions of preservice teachers using rehearsal and in-the-moment coaching in a mathematics teacher education course. Rehearsal occurs when a preservice teacher conducts a full lesson in front of peers, the professor, or both. During this time, the professor can stop the lesson and give the preservice teacher in-the-moment coaching. Afterward, the preservice teacher can continue with the lesson utilizing the information received from coaching. Regarding the matters addressed in the coaching, Averill et al. stated, "we focused on developing teaching practices suitable for eliciting mathematical thinking and managing mathematical discussions" (p. 707).

The study participants included two initial teacher education courses in a New Zealand university. Rehearsals and in-the-moment coaching were integrated throughout a one semester

course. One class of 27 preservice teachers was prepped on rehearsals and in-the-moment coaching was done by the lecturer and one of the researchers. Participants were placed into groups of four to collaboratively design and plan the lessons. A second class of 17 preservice teachers was also prepped and coached in a similar manner, however that class was also given access to online support material. Students were asked to read the material and prepare a rehearsal that each would perform individually. The data included a postcourse questionnaire comprised of a Likert scale to determine the strength of student views (10 = extremely valuable, 0 = not at all valuable), and an informal conversation with each participant. The preservice teachers valued realistic practice of teaching, as well as the immediate feedback received by the in-the-moment coaching. Participants appreciated getting feedback and immediately being able to implement suggestions made by the coaches. Averill et al. (2013) reported, "students were uniformly in favor of continued use of rehearsals and coaching . . . seldom have we experienced such unanimity of views in informal or formal feedback within our teacher education experience" (p. 710). The positive results obtained by the researchers should also be viewed in terms of the careful attention they gave to lesson construction and the amount of time used for lesson rehearsal, including the coaching that took place during each lesson.

Coaching methods to improve classroom-management skills. Coaching connected to data can be very effective (Reinke, Stormont, Herman, & Newcomer, 2014). "Fifty-two elementary school teachers trained in classroom management intervention in nine urban schools . . . were part of a trial evaluating coaching support" (p. 152). Teachers participated in six workshops spread throughout the school year. The coaching model was learner-centered, supportive, and collaborative, and focused on building teachers' strengths. The study contained a treatment group (24 members) whose members received data-driven coaching and a

comparison group (28 members), in which individuals received coaching that was not based on their performance. During the individual coaching sessions, the coach reviewed goal setting, provided feedback on teacher skills, reinforced interpersonal teaching processes, and modeled effective practices. The data-driven-coaching treatment group showed the most improvement from classroom observations measured with the school district's teacher performance rubric. Educators received feedback that used explicit data about their individual performance, thus making it easier for them to set future goals. All coaching seemed to have a positive impact, but coaching connected to data had a greater impact, $F(1, 50) = 52.57$, $p < .001$ (Reinke et al., 2014).

e-Coaching sessions and self-efficacy. Anthony, Gimbert, Fultz, and Parker (2011) conducted a study to examine the relationship between first year teachers' self-efficacy and their participation in e-Coaching. The 35 participants in this study were new mathematics teachers who were entering the teaching profession through an alternative certification program in Texas. For most of these participants, teaching was a second career. After members completed a six-week summer training course, the new teachers entered a school system. During this time, educators were assigned e-Coaches on top of their traditional in-school support systems. Instead of a coach being there in person to observe a class and give feedback, the coach used telecommunication technologies (telephones, online discussion boards, instant messaging, videoconferencing, etc.) to engage with the new teacher.

Benefits of e-Coaching, according to Anthony et al. (2011), "include the ability to address constraints related to location, scheduling, and costs" (p. 177). Yet another benefit, is "coaching sessions can be easily stored and retrieved for later use and coaches can provide support and expertise to greater number of individuals and organizations" (p. 180). Meetings with the e-Coaches were not required for the new teachers but were strongly recommended. A

version of the Teachers' Sense of Efficacy Scale survey was administered in October 2009, and a post-survey was administered in June 2010. Of the 35 mathematics teachers, 20 completed both the pre- and post-surveys. Of that, 13 completed between four and seven e-Coaching sessions, while the remaining seven did not engage in any e-Coaching. Analysis of teachers who attended the most e-Coaching sessions were those who began the school year with lower levels of self-efficacy than their colleagues. All teachers who used e-Coaching had statistically significant gains in instructional strategies efficacy and overall self-efficacy. Teachers who attended six or more e-Coaching sessions reported gains in self-efficacy overall (1.00) and in all dimensions of management (0.50). The gains were statistically significant for self-efficacy overall (Wilcoxon signed-rank test, 2-tailed, $p = .075$) and instructional strategies efficacy (Wilcoxon signed-rank test, 2-tailed, $p = .094$). Anthony et al. suggested, "that the teachers who made the most use of e-Coaching were those who perceived that their teaching practice and students' learning would benefit from their attempts to gain more content and pedagogical content knowledge" (p. 187). Whether coaching is face-to-face or implemented electronically, it provides a positive impact on teaching practices and self-efficacy. However, the trainees elected the levels of treatment (e-Coaching). This could be seen as a constraint when considering the validity of this study's outcome.

Computer Simulation in Education

The software Microsoft Flight Simulator has been used to train pilots since the early 1990s (Homan & Williams, 1998). Originally the software was considered a game for home entertainment use. However, after years of being on the market and many updates to the game had been released, pilots took note of how realistic the controls and physics of the game were. It seemed like a logical choice to use this game to give students flight experience before sitting in

an actual cockpit. Today, the Federal Aviation Administration (FAA) will count hours logged using the Microsoft Flight Simulator toward those required for getting a pilot permit (Homan & Williams, 1998). This type of simulation lends itself well to specialized domains that require hands-on experience (Shah & Foster, 2014).

Simulations in Education

Because the nature of this study is methodologically dependent on computer-simulation technology, the researcher conducted a brief review of literature on educational practices that use a type of simulation that puts the user in a scenario where he or she needs to complete tasks in a manner that mirrors a real interaction. In Table 4, two studies were found that aligned with the concept of task simulation.

Table 4

Simulations in Education

Topic/Authors	Participants	Purpose	Findings
Software-based in electronics curriculum; Chen, Hong, Sung, and Chang (2011)	Sophomore students in a university in Taiwan (n = 49)	The researchers explored how the use of software-based simulations might help in the education of high level electronics curriculums.	Posttest scores were significantly higher than the treatment group members who used a simulation ($F(1, 47) = 10.620$, $p < .05$). The analyses indicated the treatment group improved significantly, whereas the comparison group did not.
Videogame simulation in literacy attainment; Mifsud, Vella, and Camilleri (2013)	Students from two secondary schools in Malta (n = 1441)	The researchers examined the use of videogame simulation in literacy attainment of English language learners.	A significant gain in performance was attained by the experimental group, but not by the control group, when both groups were tested at the end of the experiment period.

Software-based electronics simulations. One common problem faced by learners of electronics is being unable to fully understand the abstract concepts that explain how electronics perform. This often results in failure to understand the link between models/diagrams and actual real-world circuits. Chen, Hong, Sung, and Chang (2011) explored how the use of software-based simulations might help in the education of high-level electronics curricula. Their software contained modules for visualization and manipulation of different circuit builds, and the ability to create circuits and problem-solve malfunctioning circuitry. Chen et al. stated, "learners frequently cannot understand the abstract concepts underlying the microscopic world of electrical circuits since they cannot see the flow of electric currents authentically . . . this

[simulation] lets learners interact with those concepts" (2011, p. 269). The research participants were 49 sophomore students in a Taiwan university, all of whom were taking the same course about diodes in electronics.

The electronics study used a quasi-experimental design in which 23 students were placed in a comparison group while the remaining 26 were placed in a treatment group. A pretest on diodes was given at the start of the course and a similar posttest at the end. The simulation learning activities lasted three weeks, while the comparison group had standard lab lectures and worksheets. The researchers used a two-way mixed ANCOVA to evaluate the learning performance of both groups and compare the differences between them. There were no significant differences between the pre- and posttest scores in the comparison group ($F(1, 47) = .000$, $p > .05$). The posttest scores were significantly higher than pretest scores in the treatment group ($F(1, 47) = 10.620$, $p < .05$). Thus, learning performance was higher when integrating simulation in the course versus without. Chen et al. suggested, "to increase and refine our knowledge, it would be interesting to extend the study to other learning domains, and to conduct quantitative studies involving large numbers of students using these environments in [a] real learning context" (p. 276).

Videogame simulation for English literacy. The following case study was performed to examine the use of videogames in literacy attainment of English-language learners. The study also explored the attitudes of students and parents regarding the use of videogames in the classroom. Teachers were supported in their endeavors to use videogames as a learning tool (Mifsud, Vella, & Camilleri, 2013). The study was conducted at two secondary schools in Malta, with students from ages 11 to 13. Each school housed a single sex. A total of 1,441 students participated in the study. About half of the group learned English using the traditional

methods, while the other had a videogame simulation integrated into the lessons. The study took place over one school semester and used "The Clue Finders Reading Adventures: The Mystery of the Missing Amulet," (Mifsud, Vella, & Camilleri, 2013, p. 39) as the simulated videogame.

The testing method for this study was unmodified tests that all students completed during the English language course. The results of this study were considerably favorable toward the use of videogames in the classroom. Mifsud et al. reported:

> The two groups of students who took part in the study started out with similar levels of ability in English [in a pre-assessment, however,] . . . a significant gain in performance was attained by the experimental group, but not by the control group, when both groups were tested again at the end of the experiment period. (p. 48)

The videogame experience provided a deeper level of interaction with the English language learners than what was seen from students in the traditional classroom setting. By immersing participants in an environment in which the students needed to interact and problem solve in a new language, students were more likely to retain both lower-level and higher-level language skills. Students, teachers, and parents were given surveys about their willingness to integrate videogames into the curriculum and all groups were in favor of using the technology, provided the games were integrated properly. Although, the results of this study were positive for the use of videogame integration into curriculum, one must take into consideration the type of videogame used. A game that focuses on a different type of task or gameplay style could produce a different result.

Simulation in Teacher Education

Computer-generated simulations should replicate the concepts and environment they are trying to imitate (Shah & Foster, 2014). For example, when playing a driving simulator

videogame, it helps to use a steering wheel and foot pedals instead of using a computer keyboard and mouse. The inclusion of special hardware or software can help make a simulator feel and behave more like its real-world counterpart.

Mixed-reality simulations in education. Simulating a classroom experience digitally is a complex task and there are many ways that a design team might approach creating such an experience. In 2014, researchers from the University of Central Florida set out to create a framework for individualized avatar-based interactions. The focus of this framework was to educate preservice teachers and individuals entering into the teaching field from outside industries. Other domains of study, including simulated interactions between medical personnel and patients, and counselors with clients, were also under consideration during the framework's inception. In explaining the goal of the framework, Nagendran, Pillat, Kavanaugh, Welch, and Hughes (2014) stated, "this system affords the delivery of personalized experiences that adapt to the actions and interactions of individual users, while staying true to each virtual character's personality and backstory" (p. 109). In creating the simulation, the researchers had to decide if the virtual students would be avatars or agents. An agent is a computer-controlled character that reacts to situations and makes decisions based on program rules or algorithms. An avatar is a human controlled virtual character or digital puppet.

TeachLivE. Due to the complex nature of teacher-student interactions, the avatar structure was chosen to bring to life the virtual students in the mixed-reality simulator (Nagendran et al., 2014). The researchers decided on a system in which humans, known as actors, would control the virtual students. The preservice teacher in the simulator is located in a room with a camera focused on him or her so the actors are able to see and hear the presentation, lesson, or discussion. A television displays the virtual classroom and students; as the entire

system is run digitally, the actors themselves might be off-site. In many current systems, the actors can be in California, while the participant in this simulator could be in New York (Nagendran et al., 2014).

Once a mixed-reality simulator is organized with a learning space and television that is connected to the source of the virtual classroom, the next phase is creating scenarios. For example, the researchers created a basic classroom of five students. These five students could be elementary, middle, or high school age students in their disposition and background knowledge. It is then up to the client who is using the simulator to create a scenario that focuses on specific skills or situations (Piro, Delcourt, O'Callaghan, DeSantis, & Gundel, 2017; Nagendran et al., 2014). The actors controlling the avatars need a set of parameters on which to interact with the participants. Although the actors are able to improvise, without a scenario template it may be difficult for both the avatars and the participants to reach the core goal of the simulation. Once a simulation is completed, data can be collected and the participant can be instructed. Nagendran et al. (2014) stated, "coding of events during and after these sessions is noninvasive/ safe . . . behaviors are observed during a training session and coded" (p. 127). This framework includes both the logistical rationale for creating a mixed-reality simulator and the foundation for creating its scenarios.

Mixed-Reality Simulation in Education

Because of the researcher's access to a Mursion (originally TeachLivE) simulation lab, studies that used this technology where chosen. In Table 5, three studies were found that aligned with the usage of the mixed-reality simulation system to improve teaching practices.

Table 5

Mixed-reality Simulation in Education

Topic/Authors	Participants	Purpose	Findings
Coaching in mixed-reality simulations to grow social skills with individuals identified as having an intellectual disability; Walker, Vasquez, and Wienke (2016)	18- to 22-year-old participants with an intellectual disability at a university in the southeastern USA (*n* = 5)	The researchers explored the effect of role-playing and coaching in mixed-reality simulations with intellectually disabled individuals regarding job interview social skills.	There was an average performance gain of 30.4% when comparing the participants' scores between baseline and the final simulation session.
Using TeachLivE in training teachers in a style of instruction called Discrete Trial Teaching; Garland, Pearl, and Vasquez (2012)	Graduate students who were also K-12 classroom teachers (*n* = 4)	The researchers explored using the mixed-reality simulator TeachLivE in training teachers in a style of instruction for special-needs students called Discrete Trial Teaching (DTT).	TeachLivE simulation sessions along with coaching from the professor gave improved performance in delivering DTT, and increased confidence in delivering DTT.
Rehearse teaching in TeachLivE; Khalil, Gosselin, Hughes, and Edwards (2016)	Third year students in a math Bachelor's Degree for education in their subject area (*n* = 11)	In this study, the researchers investigated "rehearse teaching" where prospective mathematics teachers used TeachLivE.	Preservice teachers had an average Reformed Teacher Observation Protocol score of 41.5 (above average) in the first teaching rehearsal in TeachLivE, which improved to an average score of 47.56 for their second session.

Coaching in mixed-reality simulations. "Preparing students and families to cope with the challenges of transitioning into society is a complex process for any student and can be especially difficult for students with disabilities" (Walker, Vasquez, & Wienke, 2016, p. 76). They explored the effect of role-playing and coaching in mixed-reality simulations with

individuals identified as having an intellectual disability regarding social skills needed for successful job-interview performance, because individuals with intellectual disabilities face poor employment outcomes. Students with disabilities in the United States face a 66% greater chance of not finding employment compared to the general population (Walker et al., 2016). Five 18-22-year-old participants with an intellectual disability were chosen for this study. An intellectual disability was defined as significant, below-average general intellectual and adaptive functioning that are manifested during the developmental period and significantly delay an individual's acquisition of academic skills. The research took place on the campus of a large, urban university in the southeastern United States in a TeachLivE virtual-classroom laboratory.

The five participants were individually assessed through their performance in the TeachLivE simulator on their ability to display behaviors from three domains: overt behaviors (eye contact, posture, and hand gestures), verbal communication, and the ability to answer content. This information created a baseline for the researchers to gauge participant progress. Interviews consisted of 11 randomized questions. The participants did not receive any coaching sessions before creating the baseline. Behaviors were recorded as either proficient or nonproficient. The treatment created for the participants was a two-step intervention. This consisted of virtual interviews through the TeachLivE simulator and subsequent coaching sessions. When in the simulator, the interviews consisted of 11 scripted questions randomly selected through a random-number generator from a bank of 27 questions. Interviews were between 10 and 15 minutes in length and scheduled six times over the course of three weeks. The simulated interviewer was controlled by a human who asked the questions and reacted to the answers accordingly. After the simulation was completed, a coaching intervention was conducted immediately afterward.

Coaching sessions were between 10 and 20 minutes in length and were based on mentoring and analyzing participant performance in the interview. The coach focused on strategies to improve participant responses. The participants' scores in the final interview were used as the post data to be compared to the baseline. In addition, two weeks after the coaching sessions were completed, a live interview was conducted with a member of the university's employee-expert panel. When comparing the participants' scores between the baseline and the final session, there was an average performance gain of 30.4%, the lowest being 18% and the highest 46%. The interviewed member of the university's employee-expert panel also scored each participant on the same rubric that was used during the live interview. The expert rating indicated an improvement in performance for each participant, with an average of 32% compared to baseline. Even though interview performance increased significantly, there was no validated score that insured employment or employability. Walker et al. (2016) concluded, "mixed-reality environments and coaching can provide instruction for individuals with disabilities, is innovative, and has many possibilities for further research" (p. 84).

Mixed-reality simulation in training teachers. Garland, Pearl, and Vasquez (2012) used TeachLivE as a training tool to explore using the mixed-reality simulator, TeachLivE, in educating teachers to instruct special-needs students with a technique called Discrete Trial Teaching (DTT). Four graduate students, who were also K-12 classroom teachers with two to 15 years of experience, were chosen for this study. This strategy uses "a highly systematic approach to learning where objectives are broken down into smaller discrete components with positive reinforcement" (Garland et al., p. 503). Participants used the TeachLivE simulator as part of their training in DTT. To measure the participants' skill growth, baseline and treatment data were collected with DTTER, an instrument that measures DTT goals. One limitation of this

study was that the simulated students did not have any knowledge of the prior lesson. Thus, student growth in the skills taught through DTT could not be measured. However, the study did determine that "coaching [strategies] in TeachLivE were numerous and included results that indicated participants . . . improved performance in delivering DTT, and increased confidence in delivering DTT" (Garland et al., p. 512). TeachLivE simulation sessions along with coaching from the professor led to a positive change in all four participant's skills in using the DTT.

Rehearse teaching in mixed-reality simulations. In 2014, a preservice teacher preparation program preformed a case study to investigate "rehearse teaching" (Khalil, Gosselin, Hughes, & Edwards, 2016, p. 767) where prospective mathematics teachers used TeachLivE. In explaining why Khalil, et al. (2016) chose mathematics preservice teachers, they stated, "for teacher preparation programs that seek to offer clinical experiences to prospective teachers, quality placements that provide the variety of resources and supports are essential…math teaching may be at a premium" (p. 768). Clinical experiences are essential to teacher development however, mathematics and other subjects are in high need and, therefore, it can be difficult to find clinical placements for preservice teachers. The solution to the shortage of quality placements may be simulated virtual classrooms. There were 11 participants in this study; all were third-year students completing the requirements of a bachelor's degree in mathematics education. The preservice teachers created a 15-minute lesson to perform in the TeachLivE simulated classroom. The lesson was videotaped and participants received feedback from two practicing educators. The preservice teachers reflected upon the experience of the lesson and feedback, revised lessons, and taught the same lesson again having made improvements and implemented suggestions. In total, this came to 30 minutes of teaching time

with two rounds of feedback from two instructors during a two-week course in teaching methodologies.

Two types of data were collected; one was a reflective journal, while the other included observations from watching the collected videos and applying the instrument, Reformed Teacher Observation Protocol (RTOP). RTOP provides a standardized mean for detecting a range of activities used in classroom instruction. Ratings are placed along a continuum from a low value for teaching as a traditional lecture (score 0-22), mid-range being an active lecture (score 23-38), high-end being active learning (score 38+). Preservice teachers had an average RTOP score of 41.5 in the first teaching rehearsal in TeachLivE. This improved to an average score of 47.56 for their second session. Khalil, et al. (2016) believed that the scores started on the higher end of the RTOP because the participants were being exposed to inquiry-based methods in their course. The data collected from the reflective journals, "indicate that the positive affective experience of their first TeachLivE session boosted their belief with regard to their ability to learn lesson planning and teaching mathematics" (p. 772). Feedback given after using the simulated learning environment enabled preservice teachers to enact instruction in a controlled and monitored setting. This also afforded participants opportunities to practice skillsets when a clinical setting was not available. Khalil et al. concluded:

> Simulations may prove to be viable alternatives for rehearse teaching in clinical settings where optimal conditions cannot be secured. Simulations may also provide candidates with early mentoring opportunities that build self-confidence while also reducing the burden of placements on already taxed schools. (p. 774)

Chapter Summary

This chapter provided the groundwork for the researcher's study. The included sections were: (a) An Explanation of the Literature Review Process, (b) Self-Efficacy Theory, (c) Self-Efficacy and Teacher Reflection, (d) Reflection in Teacher Coaching, (e) Computer Simulation in Education, (f) Simulation in Teacher Education. A preservice teacher's self-efficacy is a crucial characteristic under development during the formative years in becoming an educator (Chesnut & Cullen, 2014). We must create opportunities for them to develop the skills to become reflective practitioners (Boody, 2008). This can be done through consistent feedback and coaching on targeted skills (Delcourt & McKinnon, 2011). Using mixed-reality simulations in a preparatory teacher education program can help build skills and positive habits for preservice teachers before they enter a real-world classroom (Garland et al., 2012).

However, mixed-reality simulations are a relatively new tool in education. There has been very limited research on their impact, let alone mixed-reality simulations with preservice teachers and some of the studies had limited control conditions. The lack of research in this subject area, coupled with the need to educate preservice teachers in the most robust skill-building manner warrants this study be conducted.

CHAPTER THREE: METHODOLGY

This chapter details the methodology used to gather both quantitative and qualitative data regarding the three research questions related to this study. In this mixed-methods study, research question one addressed the types and frequency of questions the treatment and comparison group participants generated in their mixed-reality simulation session. Research question two provided an analysis of scores from a self-efficacy survey. Research question three was used to examine the qualitative data that were gathered through coaching sessions of the treatment group and an interview with all participants at the end of the study. The chapter has been divided into the following sections: (a) Description of the Setting and Participants, (b) Research Questions, (c) Research Design, (d) Instrumentation, (e) Analyses, (d) Data Collection Procedures and Timeline, and (e) Chapter Summary.

Description of the Setting and Sampling Procedures

The current study was conducted at a southern New England state university. At the time of this study, this university had a population of 5,826 students. Of that number, 528 were at the graduate level while the remaining 5,298 were undergraduates. Over 85% of the student body were in-state residents. The group of students studied in this research were undergraduate students in the school's preservice teacher-preparatory program. In the school of education, where this study took place, there were 145 students. The education program is accredited by The National Council for Accreditation of Teacher Education (NCATE, 2015). Within this teacher-preparation program, students practice lesson preparation and delivery in four courses prior to participation in a professional-development semester (PDS) during which they are assigned to a classroom in a local public school for part of the semester. After the PDS

experience, they complete student teaching for 20 weeks. The grade levels for which the candidates are preparing to teach range from elementary to secondary.

During the spring semester, having finished their classes connected to their respective content areas, the preservice teachers were in either their third or fourth education course. The class was Educational Psychology II: Childhood and Adolescence (refer to Appendix A). There were two sections of the same preservice teaching course were taught by the same professor and contained both sophomores and juniors who were scheduled to participate in mixed-reality simulation sessions as part of the curriculum.

At the start of the semester, the researcher met with members of each section in person to ask if they would participant in the study. The two groups in this study were from two course sections with either 17 or 15 students in each section. All preservice teachers in both sections agreed to participate in the study. Convenience sampling was used to select the course studied. The course used mixed-reality simulations, the researcher had accesses to the participants, and there were two sections. Course sections were randomly assigned to either treatment or comparison condition. For demographic data on the participants, refer to Table 6.

Table 6

Student Demographic Survey Data

Participant	Age	Gender	Ethnicity	Teaching Major	GPA
Treatment					
T01	19	Female	White	Elementary (K-6)	3.41
T02	19	Female	White	Secondary (7-12) Health	3.50
T03	20	Female	White	Elementary (K-6)	3.70
T04	21	Female	African American	Elementary (K-6)	3.21
T05	20	Female	African American	Elementary (K-6)	3.63
T06	19	Female	White	Elementary (K-6)	3.80
T07	19	Female	White	Elementary (K-6)	3.94
T08	19	Female	White	Elementary (K-6)	3.42
T09	20	Female	White	Elementary (K-6)	3.70
T10	21	Female	Asian	Secondary (7-12) Health	3.70
T11	22	Male	African American	Secondary (7-12) Spanish	3.06
T12	25	Female	White	Secondary (7-12) Math	3.37
T13	24	Female	African American	Secondary (7-12) Health	3.31
T14	25	Male	White	Elementary (K-6)	3.20
T15	19	Female	White	Secondary (7-12) Chem.	3.66
Comparison					
C01	25	Female	White	Secondary (7-12) Health	3.65
C02	19	Male	White	Secondary (7-12) Chem.	NA
C03	20	Female	White	Secondary (7-12) Health	3.70
C04	20	Male	White	Elementary (K-6)	3.57
C05	21	Male	White	Secondary (7-12) Music	3.83
C06	20	Female	White	Secondary (7-12) Music	3.01
C07	19	Male	White	Secondary (7-12) Music	3.56
C08	21	Female	White	Secondary (7-12) Music	3.88
C09	20	Female	Asian	Elementary (K-6)	3.34
C10	19	Female	White	Secondary (7-12) Music	3.96
C11	22	Female	White	Secondary (7-12) Music	3.92
C12	19	Female	Hispanic	Secondary (7-12) Music	3.48
C13	19	Female	White	Secondary (7-12) Music	3.92
C14	20	Female	White	Secondary (7-12) Music	3.48
C15	34	Female	White	Elementary (K-6)	3.63

Note. The treatment group started with 17 members but 2 were removed from the study due to incomplete data. Consent was granted for GPA data to be obtained from university transcripts.

Research Questions

The following research questions will be addressed in this study:

1. Is there a Is there a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores for the number and types of questions they asked while teaching lessons and the other does not?

   Non-directional Hypothesis: There is a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores for the number and types of questions they asked while teaching lessons and the other does not.

2. Is there a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not?

   Non-directional Hypothesis: There is a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not.

3. What are the perceptions of preservice teachers' abilities and experiences in using a mixed-reality simulation where one group receives data-driven feedback and coaching throughout a

semester about their performance scores for the number and types of questions they ask while teaching lessons and the other does not?

Research Design

This research study was conducted using a mixed-methods embedded design in which quasi-experimental quantitative data were the main evidence for the study while the secondary evidence was qualitative (case study) in nature (Creswell & Clark, 2011). Refer to Figure 1 for a depiction of the mixed-methods design. In spring 2017, data were collected from one course section of students who served as the treatment group and another section that was designated as the comparison group. The mixed-reality simulation was not part of the treatment (both groups performed lessons in the simulator), data-driven feedback and coaching is the treatment.

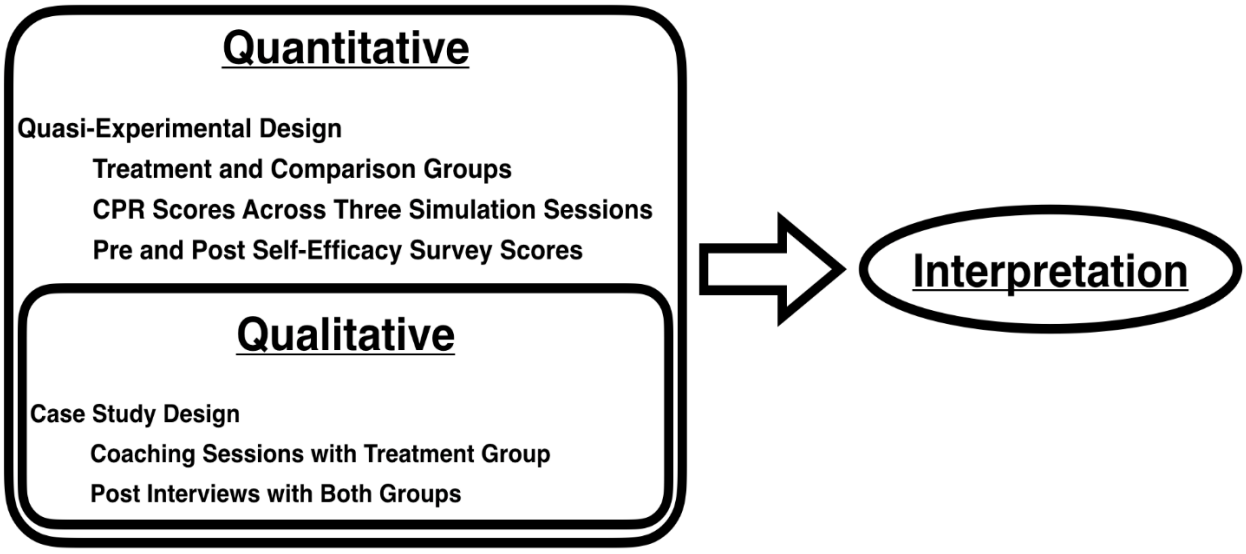

Figure 1. Research design used is an embedded design (Creswell & Clark, 2011).

Quantitative Design

Course sections were randomly assigned to either treatment or comparison condition and engaged in the study using the quasi-experimental research design plan (Gall, Gall, & Borg, 2006) indicated in Figure 2. All students in both sections were at similar points in their programs of study, and the same professor taught both sections.

The study was explained to all members of the treatment and comparison groups. All members consented to participate and were administered a teacher survey regarding their self-efficacy. The researcher arranged to speak with each member of the treatment group in order to collect baseline data about his or her understanding of the inquiry practice of questioning. The researcher also used this opportunity to begin coaching each participant in types of questions that could be incorporated into a lesson and how to formulate questions. These feedback and coaching sessions continued throughout the semester, using the plan outlined in Figure 2.

The researcher collected questioning data of each session for both groups. All the participants completed the Teacher Self-Efficacy Survey (TSES) at the start of the semester and again at the end of the semester.

Group	Feedback Coaching 1	Simulation Session 1	Feedback Coaching 2	Simulation Session 2	Feedback Coaching 3	Simulation Session 3	Final Interview 4
Treatment	X	O	X	O	X	O	X
Comparison		O		O		O	X

Figure 2. Quasi-Experimental design for treatment and comparison groups for gathering quantitative data (Gall et al., 2006).

Qualitative Design

A case-study method was used to describe the experiences and gain insight into the perceptions of the preservice teachers participating in this study (Creswell & Clark, 2011). A separate case study was performed for each group in the study (treatment and comparison); each was bounded by the skill of higher-order thinking through questioning. The treatment group case study included three coaching sessions, each of these was audiorecorded via phone and a final interview was also recorded. The comparison group's case study contained only the final phone interview. All recordings were later transcribed and coded to gain an understanding of the experiences of each participant. Both the coaching sessions and final interview transcripts were analyzed using summative content analysis (Saldaña, 2016).

Course Description

The 15-week course titled Educational Psychology II: Childhood and Adolescence (refer to Appendix A for a course description) contained two sections of student teachers. Both course sections were taught by the same professor, who was not part of the study. The course included a range of topics including the use of questioning skills in the classroom. Distributed throughout the semester, each preservice teaching candidate was scheduled to present three 10-minute sessions using the mixed-reality simulation. During each session, a teacher candidate taught a lesson related to his or her area of specialization within the teacher-certification program. Content areas included English, history, mathematics, music, and science. Each lesson needed to target the high-leverage practice of higher-order thinking through the use of questioning skills (Piro & O'Callaghan, 2016). High-leverage practices are skills an educator can use while teaching to positively effect student learning in the desired content area (Ball & Forzani, 2010). All mixed-reality simulation sessions, although mandatory, were not integrated into the

curriculum of the semester-long course. The performance of the preservice teaching candidates in the simulator was not connected to their course grade (refer to Appendix B for the mixed-reality simulation session rubric).

Mixed-Reality Simulations. During mixed-reality simulation sessions each preservice teacher candidate presented his or her lesson in a room with a simulation facilitator. The facilitator makes sure the simulation is working properly with Mursion, videorecords each lesson, monitors time so that each student stays on schedule, and gives short feedback after each candidate has taught his or her lesson. Because classmates are also present during each lesson, they can provide comments or suggestions to the participant after a lesson is performed. Due to time constraints during the simulation process, several participants received brief feedback or no feedback from the facilitator or their peers. After each session, the researcher viewed all videorecorded lessons in order to take notes on all lesson topics, questions posed, and responses. This information was used in follow-up sessions with treatment-group members and was provided to the comparison group members at the end of the study. The audiorecording from each session was later transcribed to verify the researcher's notes.

Treatment group. Individuals in the treatment group taught their lessons in the mixed-reality format described above and, within one to three days after teaching a lesson, received data-driven feedback and coaching from the researcher by phone or other electronic method. Each conversation included (a) the number and types of questions asked in the prior teaching session, (b) the development of questions used during a lesson, and (c) the formation of a plan to improve higher-order questioning techniques in a future lesson. At the end of the study, a final phone interview was conducted with each member of the treatment. This interview included the

topics of lesson preparation, performance, and perceptions of the simulation experience. See Appendix C for a list of the final interview questions.

Comparison group. Individuals in the comparison group participated in the mixed-reality simulation format already described, in which each preservice teacher designed and presented three 10-minute lessons during the 15-week semester. At the end of the study, a final phone interview was conducted with each member of the comparison group.

Data Collection Procedures and Timeline

Refer to Table 7 for a timeline of the data collection procedure.

Table 7

Data Collection Timeline and Procedure

Date	Procedure
Jan 24-27, 2017	Consent was gained for the participants and TSES pretest
Jan 26-29, 2017	Report data/coaching to treatment group
Jan 30, 2017	Session 1-Treatment group and comparison group (same day)
Feb 1-3, 2017	Report data/coaching to treatment group 1-3 days later
Mar 2, 2017	Session 2-Treament group
Mar 3, 2017	Session 2- Comparison group
Mar 3-5, 2017	Report data/coaching to treatment group 1-3 days later
Mar 30, 2017	Session 3- Comparison group and TSES posttest
Mar 31, 2017	Session 3-Treament group and TSES posttest
Apr 1-8, 2017	Conducted final interviews with treatment and comparison group

Instrumentation

Student Demographic Survey

Basic demographic data were collected from a questionnaire. The type of information collected from the students included age, racial or ethnic status, biological sex, and content-area major. This information took approximately 5 to 10 minutes for the participants to complete. GPAs were added to this data by the researcher with permission from the participants. For this information refer to Table 6.

Classroom Practices Record

This study employed the instrument known as the Classroom Practices Record (CPR; Westberg, Archambault, Dobyns, & Salvin, 1993). This instrument was originally created "to document the differentiated instruction that gifted and talented students receive through modifications in curricular activities, materials, and verbal interactions between teachers and students" (p. 81). In its original design, the CRP contained six core sections of measurement, which included identification of targeted students, information about the students, physical environment inventory of the classroom, curricular activities included in the observed lesson, verbal interactions during the observed lesson, teacher interview record, and daily summary of the observation.

This instrument was used to collect data on the amount of Higher-order Thinking (HOT) and Knowledge/Comprehension (K/C) questions generated in each of the observed lessons for all interactions between the teacher candidate and simulated students (avatars). Therefore, Verbal Interactions, the Teacher Interview, and the Daily Summary were the only parts of the CPR that were used in this study. Each session was videorecorded and all verbal interactions were transcribed by a professional typist. The Daily Summary was used to record and label all

questions observed in the classroom. Phone meetings were scheduled with each member of the treatment group during which each preservice candidate was presented with the results of his or her use of questions during the session and asked about methods to improve the use of higher-order questions in the next session. The researcher was trained to use these sections on the CPR. There is a complete training manual with sample exercises included in the CPR (Westberg et al., 1993).

Validity and Reliability of the CPR. Before the Classroom Practices Record was released to the public it underwent "several field trials to improve evidence of its validity and reliability" (Westberg et al., 1993, p. 25). Since then the CRP has been used by researchers because of its versatility and the data one can gain from it (Delcourt & McKinnon, 2011). Additionally, as this instrument has a training section, the researcher can insure that the best practices are being used when coding the transcripts from the sessions.

Videorecordings of the Sessions

The researcher created a custom videorecording system to capture the participants using the mixed-reality stimulator (see Figure 3). This was designed to generate an archive of the participants' performance so the researcher could rewatch the session multiple times to code the questions employed by the teacher candidate during each mixed-reality simulation session. The researcher also wanted to gauge his coding against an expert. Because the expert could not attend these sessions the videorecordings needed to be easily accessible.

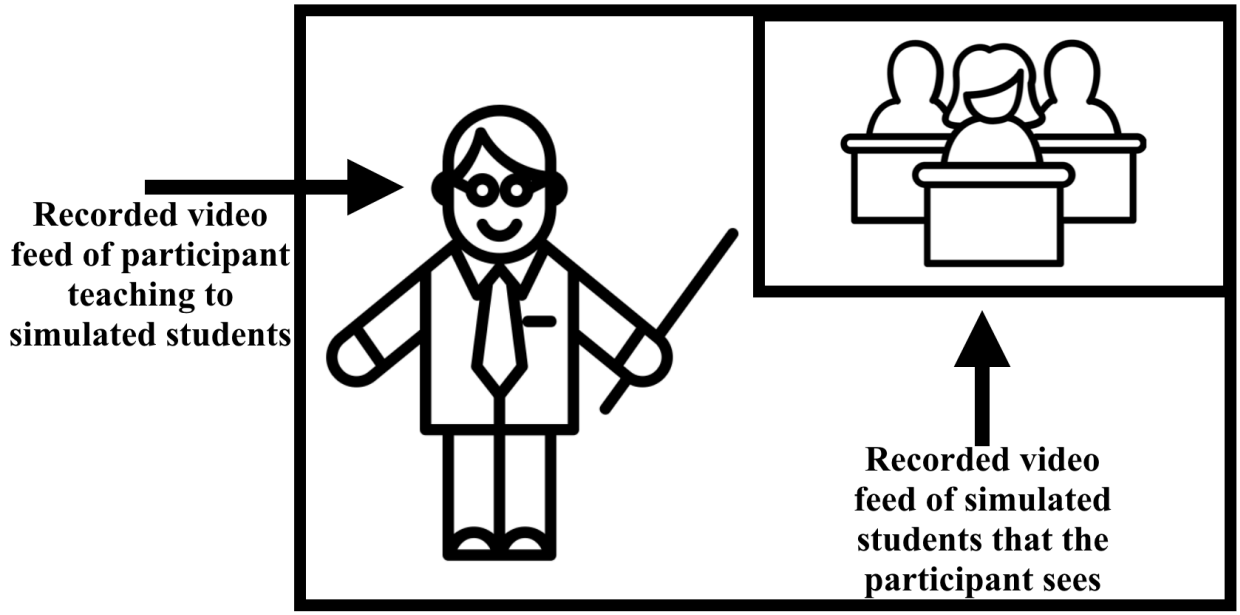

Figure 3. Recorded image produced from the custom hardware and software created by researcher.

Coaching Protocol

The CPR was used to record the amount, and type of questioning the preservice teachers and simulated students created during each mixed-reality simulation session over the course of a semester. These sessions were observed live by the researcher. The questioning type created by the preservice teacher was categorized as representing either Higher-order Thinking (HOT) or Knowledge/Comprehension (K/C). Each question category was summed for each session. One to three days after the session the researcher contacted each preservice teacher in the treatment group by phone or Internet conference service and discussed his or her lesson performance, planning tactics, and strategies for the next teaching session (see Appendix D for the coaching protocol). In total, there were three 15- to 25-minute over-the-phone feedback-coaching sessions made before the final interview with each participant of the treatment group.

Teachers' Sense of Efficacy Scale

This study employed the instrument known as the Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Hoy, 2001). The TSES is divided into three subscales: efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management. At the beginning and end of the semester, both treatment and comparison groups completed the survey. The survey has 24 items, the responses are recorded using a 9-point Likert scale, and the time of completion is five to 10 minutes. When using the TSES with preservice teachers the creators recommend that the researcher use a total summed score for all items instead of using the individual subscales. Their reasoning behind this direction is due to the observation that preservice teachers' responses are often less distinct between subscales as compared to experienced teachers. For this study, the researcher followed the recommendation of the creators of the TSES and used the sum of the items to report the results. In determining what is a low, medium, or high score the creators of TSES suggest that any score above a 3 be considered medium, while a score above 6 is high.

Reliability of the TSES. Many aspects of the TSES were tested before it was made available to the research community in 2001 (Tschannen-Moran & Hoy, 2001). It has been in use for over 15 years with many studies conducted to gauge its reliability. A 2012 study was conducted to examine its factorial, predictive, convergent, and discriminant validity, as well as its internal consistency reliability (Nie, Lau, & Albert, 2012). Validity reports about the TSES included comparisons to other scales and participant interviews with educational psychologists. One hundred and nine primary and secondary school teachers in Singapore participated in this research. The results for internal consistency reliability (Cronbach's α) for the TSES subscales of behavior management strategies, instructional strategies, and motivational strategies were .88,

.87. and .77, respectively (Nie, Lau, & Albert, 2012). The TSES is an affective measurement instrument. Affective instruments with a Cronbach's α at or above .70 are considered to have appropriate reliability (Gable, 1986). Regarding the validity of the TSES, Nie et al. (2012) stated, "the high correlations between teacher efficacy beliefs and teaching strategies indicated that TSES had good predict[ive] validity" (p. 418).

Participant Interview

When all three sessions were completed, each participant in the treatment group and the comparison group were interviewed to gauge how the process using the mixed-reality simulation was received. While these interviews were conducted, they were digitally recorded over the phone. The researcher asked 10 (see Appendix C). Questions 1 through 5 addressed the changes made to the candidate's performance in the classroom. These topics included their preparation techniques, perspectives of the in-class performances, insights about the student interactions, and the changes that they made in their teaching. Questions 6 through 8 addressed the coaching they received. These topics included their thoughts on the coaching in general, how the coaching effected their planning, and how the coaching effected their overall performance. The final two questions asked the candidates about how the mixed-reality simulation experience could be improved in the future. Each interview lasted between 15 and 25 minutes.

Analyses

Research Question 1

Is there a statistically significant difference in posttest scores on the Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Hoy, 2001) for candidates in a teacher-certification program, using a mixed-reality simulation, in which one group receives data-driven feedback and coaching about their performance scores for the number and types of questions they ask while

teaching lessons and the other does not? This quantitative research question employed a survey completed twice by the participants. Type of program, coaching/feedback and no coaching/feedback served as the independent variable. The same survey was given at the start (pre) of the spring semester and again at the end (post) of that same semester, serving as the dependent variable. The TSES contains 24 items. Each item uses a nine-point Likert-scale response format. These data were interval in nature and analyzed using an ANOVA (Hinkle et al., 2003). An ANOVA procedure can show whether the mean difference between paired (pre and post) observations is significantly different.

Research Question 2

Is there a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not? This quantitative research question employed the amount and types of questioning the preservice teachers created during each session over the course of a semester. The lesson presentations were coded based on the levels of questions and the responses between the teacher candidate and the avatars. These data were interval when collected. However, because of the large performance difference between the treatment and comparison group--the comparison group showed no variability because there were so few questions generated, the researcher made the data categorical. Because of this, a two-sample case Chi-Square procedure was conducted. The sum of all leveled HOTs and K/C questions per session was the dependent variable in the analysis and the type of program, coaching/feedback and no coaching/feedback served as the independent variable (Hinkle, Wiersma, & Jurs, 2003). Further analysis was conducted to explore performance between the three sessions of the

treatment and comparison groups. For this follow-up procedure, a matched-pair sign test was conducted. This test is most commonly used to test for a difference in the mean of paired observations for categorical data (Hinkle et al., 2003). The amount of HOTs questions produced from both the treatment and comparison groups were analyzed between sessions 1 and 2, 2 and 3, and 1 and 3, then a binomial calculation was conducted for each procedure to examine whether or not the calculations were significant (Hinkle et al., 2003).

Research Question 3

What are the perceptions of preservice teachers' abilities and experiences in using a mixed-reality simulation, in which one group receives data-driven feedback and coaching throughout a semester about their performance scores for the number and types of questions they ask while teaching lessons, and the other does not? This research question is qualitative and required coding of each interview that was conducted at the end of the study. The coaching sessions for the treatment group were also coded to gain insight into the effect of the coaching. Each coaching session was coded based on the responses of the treatment participants to the coaching protocol. Once the interviews were transcribed, a summative content analysis (Saldaña, 2016) was used to gain information from participants' responses. Summative content analysis was used to code keywords or phrases. These keywords or phrases were chosen based on the interest of the researcher or were deemed of value from a review of the literature (Saldaña, 2016). Because these data were collected without a framework, this research used emerging inductive codes. This process can allow findings to emerge from the data.

Chapter Summary

This chapter indicated the methods used by the researcher to gather information about the quantitative and qualitative aspects of this research regarding the questions generated from

preservice teachers' using a mixed-reality simulation in a teacher-preparatory program. The study used a mixed-methods approach. The quantitative data collected were the types and amounts of questions participants generated in their mixed-reality simulation session along with scores of a self-efficacy survey taken at the start of the course and at the conclusion. One group received a standard class experience (comparison) while the other received that standard class experience with the addition of data-driven coaching on questioning skills (treatment). The qualitative data were gathered through transcripts of the coaching sessions with the treatment group, and a final interview with all participants in at the end of the study.

CHAPTER FOUR: ANALYSIS OF DATA

The purpose of this study was to examine the effect of coaching preservice teachers using a mixed-reality simulation in regard to questioning skills. The following chapter provides an analysis of data collected, data cleansing, and a detailed explanation of the analyses and results each of the three research questions. The structure for this research was based on the three questions Indicated in Chapter Three.

Collected Data and Cleansing

At the beginning of the data-gathering process for this study there were 32 participants, 17 in the treatment group and 15 in the comparison group. The researcher assigned a unique numeric identifier to each participant to maintain confidentiality. All data were screened for missing values, errors, or inconstancies using a visual inspection process. Next, participant retention was determined by two factors: (a) that participants completed most of the mixed-reality simulations, and (b) that members of the treatment group received the coaching and feedback treatment (Meyers, Gamst, & Guarino, 2006). Two of the 17 students in the treatment group were eliminated from these analyses because they did not complete all three mixed-reality simulations and, therefore, missed the related data-driven feedback and coaching session. Thus, they did not receive the complete treatment. Although one of the 15 students in the comparison group missed the third (final) teaching simulation session, he remained in the analyses for sessions one and two but his data could not be used for session three.

Analysis of Student Achievement

An analysis of the participants' overall Grade Point Average (GPA) was conducted to gain insight about any difference in mean achievement scores between the treatment and comparison groups prior to the implementation of the study. Because the consent form included

permission for the researcher to obtain these data, the GPAs were obtained by the researcher via University records. One comparison-group participant's GPA could not be included in this analysis because he was a transfer student and his overall GPA was not available. An independent-samples *t*-test was conducted in SPSS to examine the significance of the difference between the treatment group and the comparison group members with regard to their GPAs (Meyers et al., 2006).

Independent Samples *t*-test Assumptions

Independence. During this research no member of the treatment group or comparison group was ever a member of the other group. The course sections for both groups had no interactions during this study or the prior semester.

Test of normality. In analyzing the Skewness and Kurtosis of the GPA data (refer to Table 8), the comparison group value for skewness (-1.12) was slightly beyond the criterion of ±1 required to meet the assumption of normality according to Meyers et al. (2006). Meaning that the distribution is skewed to the left (negative direction). Thus, a Shapiro-Wilk Statistic was conducted. The Shapiro-Wilk test is based on the correlation between the data and the corresponding normal scores, a null-hypothesis of this test is that the population is normally distributed (Meyers et al., 2006).

Table 8

GPA Skewness and Kurtosis

Group	Statistic	Std. Error
Treatment: Data-driven feedback and coaching		
Skewness	-0.01	0.58
Kurtosis	-0.29	1.12
Comparison: No data-driven feedback and coaching		
Skewness	-1.12	0.60
Kurtosis	1.69	1.15

In Table 9, using $\alpha = .001$ (Hinkle et al., 2003), the Shapiro-Wilk statistic was significant at $p = .165$ for the comparison group. This led the researcher to conclude that each group met the assumption of normality.

Table 9

Shapiro-Wilk Test of Normality

Group	Statistic	*df*	*p*
Treatment: Data-driven feedback and coaching	0.98	15	0.946
Comparison: No data-driven feedback and coaching	0.91	14	0.165

Homogeneity of variance. Table 10 provides information about the descriptive statistics for this analysis.

Table 10

Group Statistics: GPAs of Treatment and Comparison Groups

Group	*n*	*Mean*	*SD*	*Std. Error Mean*
Treatment: Data-driven feedback and coaching	15	3.49	0.23	0.06
Comparison: No data-driven feedback and coaching	14	3.65	0.26	0.07

In Table 11, Levene's Test for Equality of Variances was not significant at $p = 1.00$ with an a priori .05 alpha level. Therefore, the assumption of homogeneity of variance was met for this analysis.

Table 11

Independent Samples t-test: GPAs of Treatment and Comparison Groups

	Levene's Test for Equality of Variances		*t*-test Results for Equality of Means				
	F	*p*	*t*	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	0.00	1.00	-1.77	27	0.087	-0.16	0.09

Independent Sample *t*-test Results

Table 10 indicates that there was no significant difference between the GPAs for the treatment group ($M = 3.48$, $SD = .23$) and comparison group ($M = 3.64$, $SD = .25$), $t(27) = -1.77$,

$p = .09$. Therefore, GPA of the participants was not a factor of consideration in analyzing the findings for the three research questions.

Research Question One

Is there a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher-certification program, using a mixed-reality simulation, in which one group receives data-driven feedback and coaching about their performance scores for the number and types of questions they ask while teaching lessons and the other does not?

Nondirectional Hypothesis: There is a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher-certification program, using a mixed-reality simulation, in which one group receives coaching and feedback about their performance scores for the number and types of questions they ask while teaching lessons and the other does not.

Data Collected

The Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Hoy, 2001) was completed twice by the participants, with the same survey being given at the start of a semester, and again at the end of the semester. The TSES contains 24 items, where each item uses a nine-point Likert-scale response format. All participants completed all items on the presurvey. Two participants in the comparison group did not complete the postsurvey. Descriptive information regarding the TSES is provided in Table 12.

Table 12

Group Statistics: TSES Mean Scores of Treatment and Comparison groups

Group	*n*	*Mean*	*sd*	*Std. Error Mean*
Pretest				
Treatment: Data-driven feedback and coaching	15	7.39	0.93	0.24
Comparison: No data-driven feedback and coaching	15	6.76	1.07	0.28
Posttest				
Treatment: Data-driven feedback and coaching	15	7.47	0.55	0.14
Comparison: No data-driven feedback and coaching	13	6.98	1.01	0.28

ANOVA Assumptions for TSES Pretest Scores

An ANOVA was conducted in order to examine if there were any significant difference in TSES pretest scores prior to the treatment. An examination of the scores differences between groups is presented below.

Assumption of independence. During this research no member of the treatment group was a member of the comparison group or vice-versa. The course sections for both groups had no interactions with respect to their course meetings.

Assumption of normality. An ANOVA is a parametric test that requires the data be normally distributed within one standard deviation (Hinkle et al., 2003). The Skewness and Kurtosis values for the pretest data are located in Table 13. All values for the TSES pretest data for the treatment group were within the criterion of ±1 (Hinkle et al., 2003). Thus, the assumption of normality was met.

Table 13

TSES Pre-Scores Skewness and Kurtosis

Group	Statistic	Std. Error
Treatment: Data-driven feedback and coaching		
Skewness	-0.37	0.58
Kurtosis	-0.50	1.12
Comparison: No data-driven feedback and coaching		
Skewness	-0.36	0.62
Kurtosis	-0.40	1.19

Homogeneity of variance. In Table 14, the Levene's Test for Equality of Variances was not significant, $p = 0.42$, using an a priori level of .05. Therefore, the assumption of homogeneity of variance was met for these data.

Table 14

Levene's Test for Equality of Variances

Survey	*F*	*df1*	*df2*	Sig
TSES Pre	0.67	1	28	0.42

ANOVA Results for TSES Pretest Scores

These data are interval in nature and were analyzed using an ANOVA for the TSES pretest scores (Hinkle et al., 2003). An ANOVA procedure was conducted to examine difference between, the treatment and comparison groups' TSES prescores. Table 15 indicates that there

were no statistically significant differences between group means as determined by the ANOVA, $F(1,28) = 2.94$, $p = 0.10$ between the treatment and comparison groups' TSES pretest scores.

Table 15

ANOVA Test TSES Pretest Scores

Source	Type III Sum of Squares	*df*	Mean Square	*F*	*p*	Partial Eta Squared
Corrected Model	2.96	1	2.96	2.94	0.10	0.10
Intercept	1502.76	1	1502.77	1494.89	0.00	0.98
Number Group	2.96	1	2.96	2.94	0.10	0.10
Error	28.15	28	1.01			
Total	1533.87	30				
Corrected Total	31.11	29				

ANOVA Assumptions of TSES Posttest Scores

Independence. During this research no member of the treatment group was a member of the comparison group or vice-versa. The course members of each group had no interactions with respect to their course goals and objectives, or course meetings.

Assumption of normality. The Skewness and Kurtosis values for the posttest data are located in Table 16. Both values for the TSES posttest data for the treatment group were higher than the criterion of ±1 needed to meet the assumption of normality (Hinkle et al., 2003).

Table 16

TSES Posttest Scores Skewness and Kurtosis

Group	Statistic	Std. Error
Treatment: Data-driven feedback and coaching		
Skewness	1.36	0.58
Kurtosis	2.07	1.12
Comparison: No data-driven feedback and coaching		
Skewness	0.21	0.62
Kurtosis	0.27	1.19

In this case, Meyers et al. (2006) recommend conducting a Shapiro-Wilk test to analyze the correlation between the data and the corresponding normal scores (2006). The population is normally distributed if the null-hypothesis of this test is supported. In table 17, a criterion of $\alpha = .001$ was used to assess the test statistic, as recommended by Meyers et al. (2006). Since the value produced by the Shapiro-Wilk test was not significant at $p = .06$ for the treatment group, the researcher concluded that the group has met the criterion for normality.

Table 17

Shapiro-Wilk Test of Normality

	Groups	Shapiro-Wilk Statistic	*df*	Sig.
TSES post	Treatment	0.89	15	0.06

Homogeneity of variance. Levene's Test for Equality of Variances was significant with $p = .04$ for the TSES posttest scores (see Table 18). Therefore, the assumption of homogeneity of variance was not met for these data. To address this issue the researcher decided to conduct an ANCOVA. This procedure is recommended by Hinkle et al. (2003) to adjust the scores for error, specifically to partition out the variation attributed to extraneous variables.

Table 18

Levene's Test for Equality of Variances

Survey	*F*	*df1*	*df2*	*p*
TSES Post	3.41	1	26	0.04

ANCOVA Results for TSES Post-Scores

Homogeneity of variance for ANCOVA. In Table 19, Levene's Test for Equality of Variances was not significant, $p = 0.08$, using an a priori criterion level of .05. Therefore, the assumption of homogeneity of variance was met for these data. The researcher decided to use the TSES pretest scores as a covariate in conducting the ANCOVA procedure for the posttest scores.

Table 19

Levene's Test for Equality of Variances ANCOVA

Survey	*F*	*df1*	*df2*	*p*
TSES Post	3.41	1	26	0.08

These data were interval in nature and analyzed using an ANCOVA for the TSES posttest scores (Hinkle et al., 2003). The ANCOVA procedure tests for significance between the treatment and comparison groups' TSES, while the TSES pretest scores were used as a covariate. Table 20 provides the results of the ANCOVA, indicating that there were no statistically significant differences between the treatment and comparison groups' TSES posttest scores, after covarying for initial differences in pretest scores, $F(1,25) = 0.66$, $p = 0.42$.

Table 20

ANCOVA Test TSES Post-Scores

Source	Type III Sum of Squares	*df*	Mean Square	*F*	*p*	Partial Eta Squared
Corrected Model	6.48	2	3.24	6.83	0.00	0.35
Intercept	9.66	1	9.66	20.37	0.00	0.45
Pretest	4.81	1	4.81	10.16	0.00	0.29
Group	0.31	1	0.31	0.66	0.42	0.03
Error	11.85	25	0.47			
Total	1487.05	28				
Corrected Total	18.32	27				

TSES Review of Results

After comparing the means from both groups and reviewing the results of the ANCOVA, the lack of a significant effect may be due to the fact that participants in both groups started the semester with high TSES scores and ended with high TSES scores. Both groups may have had high TSES scores since all candidates participated in a total of six simulation sessions for two prior semesters and were comfortable in performing within the simulator. This is positive for the program as a whole, and further insights will be addressed in Chapter Five.

Research Question Two

Is there a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality

simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not?

Non-directional Hypothesis: There is a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives coaching and feedback about their performance scores and the other does not.

Data Collected

To address the first quantitative research question, the researcher examined the amount and type of questioning the preservice teachers asked of the simulated students during their lesson presentations in the mixed-reality simulation sessions over the course of a semester. Those questions were identified using the instrument known as the Classroom Practices Record or CPR (Westberg et al., 1993). This tool was used to record all lesson interactions, which were later coded. The researcher calibrated his coding process for using this instrument by comparing his findings with those of an expert researcher who used the same instrument from five randomly selected participant videos. There was 100% agreement between the coders. All questions asked during each lesson presentation were coded as knowledge/comprehension (K/C) or higher-order thinking (HOT) content based on the levels of questions the teacher candidate asked the simulated avatars. To review the full set of questions asked by the preservice teachers in both groups refer to the recorded participant K/C and HOT questions in Appendix E.

Analysis of Research Question Two

These data were interval in nature when collected. However, because of the large performance difference between the treatment and comparison group, where the comparison group results had little variability in the number of generated HOT questions because there were so few questions produced during their lesson presentations, the researcher determined that the

data needed to be categorical. As a result, a two-sample case Chi-Square procedure was conducted. The sum of all leveled HOTs and K/C questions per session was the dependent variable in the analysis and the type of program, data-driven feedback and coaching and no data-driven feedback and coaching served as the independent variable (Hinkle et al., 2003). The two-sample case Chi-Square was conducted using the software, Microsoft Excel (Office, 2016). The researcher analyzed the sum of all K/C and leveled HOT questions as the dependent variables in the analysis of the type of program, data-driven feedback and coaching as compared to no data-driven feedback and coaching, which served as the independent variable for the Chi-Square. The result was examined against an upper percentage points χ^2 distribution table using an a priori value of $p \leq 0.05$ (Hinkle et al., 2003).

Chi-Square Assumptions

Sample-size assumption. The criterion for sample size in a Chi-Square procedure is that no data in the expected cells should be less than a value of five (Hinkle et al., 2003). Refer to Table 21 for frequencies in the expected cells. Because no values were less than five, the sample-size assumption was met.

Independence assumption. A Chi-Square procedure using a two-sample case cannot be used with correlated data. The data for the treatment and comparison groups were originally recorded across three sessions. The data from those three sessions were collapsed into total sums for the of K/C questions and a separate total for the number of HOT questions across the entire semester. Because the summed data were used to calculate the responses across the three sessions, these data were not correlated, meeting the assumption for independence. In addition, the groups were separate throughout the study since the participants were registered in separate course sections, one online and one hybrid.

Chi-Square Procedure

Table 21 indicates that the Chi-Square analysis resulted in a significant difference in performance between the types of questions asked (K/C and HOT) by the treatment and comparison group members, using an a priori value of $p \leq 0.05$, ($\chi^2(1) = 47.56$, $p < .01$). This significant result led the researcher to accept the nondirectional hypothesis for research question one.

Table 21

Two-Sample Case Chi-Square Calculation and Result

Group	Question Type	Observed (O)	Expected (E)	$((O-E)^2)/E$	Residual $(O-E)/\sqrt{E}$
Treatment: Data-driven feedback and coaching	K/C	112	135.72	4.15	-2.04
	HOT	54	30.28	18.59	4.31
Comparison: No data-driven feedback and coaching	K/C	148	124.28	4.53	2.13
	HOT	4	27.72	20.39	-4.51
χ^2				47.46	

Note. The Calculated χ^2 is greater than the critical value of 10.83. It is significant at $p < .01$.

Interpreting the Residuals. When a residual in a Chi-Square procedure is above the absolute value of two then that residual is an important contributor to a significant Chi-Square statistic (Hinkle et al., 2003). In this case, all four residuals were important contributors to the Chi-Square value. The treatment group residuals are -2.04 and 4.31 for the K/C and HOT questions, respectively. The observed K/C was 112 which was lower than the expected value of 135.72. In addition, the observed number of HOT questions was 54, which was well above the expected value of 30.28.

The comparison group residuals are 2.13 and -4.51 for the K/C and HOT questions, respectively. The 148 observed K/C questions exceeded the expected 124.28. However, the total number of HOT questions observed was 4 while the expected was 27.72. The observed amount of HOT questions fell extremely short of the expected amount resulting in the largest residual for the Chi-Square procedure. In fact, the expected number of HOT questions was 6.9 times greater than the actual number of higher-order-thinking questions posed by members of the comparison group.

Follow-up Analysis: Matched Pair Sign Test

A follow-up analysis was conducted to explore performance between the three sessions of the treatment and comparison groups in order to examine performance in HOT question creation over time. Therefore, the research question here addresses if there is a significant different in HOT question performance between all paired sessions in which one group received data-driven feedback and coaching and the other did not. A matched pair Sign test was conducted for each group with respect to the HOTs question performance. The following pairwise comparisons were used to analyze the number of HOT questions posed for all three

sessions: 1 and 2, 2 and 3, and 1 and 3. Then a binomial calculation was conducted for each paired comparison to find the level of significance (Hinkle et al., 2003).

Matched Pair Sign Test Assumptions

Two samples are compared. The number of HOT questions per session was collected from all treatment and comparison group lesson presentations. Both groups were separate during the entire duration of the study. Therefore, the two-samples assumption was met.

Dependent samples. Paired matched data sets were used for both the treatment and comparison groups to analyze HOT question performance data between two sessions at a time (sessions 1 and 2, 2 and 3, and 1 and 3). The data for each session came from the exact same participants for each of the three sessions. Therefore, the dependent-sample assumption was met.

Matched Pair Sign Test

Tables 22 to 24 display the matched pair Sign test procedures that were conducted to locate significant differences in numbers of HOT questions posed between sessions 1 and 2, 2 and 3, and 1 and 3 for each of the treatment and comparison group members. Each pairwise comparison was analyzed by subtracting the number of HOT questions in a recent session (session 2) from an earlier session (session 1) for each participant. For example, participant T03 asked two HOT questions in session 1 and three HOT questions in session 2 (2 - 3 = -1). Since -1 is a negative value, a - sign is attributed to the calculation. The negative sign means that the participants asked *more* HOT questions in the second session than the first. When the result is positive, a + sign is attributed to the calculation. This means the participants asked *fewer* HOT questions in session two as compared to session one. The + signs are added separately from the total number of – signs to indicate the influence of each type of sign in the analysis. Negative

signs (-) mean growth in HOT questions while positive signs (+) mean a reduction in HOT questions.

Table 22

Matched Pair Sign Test Procedure for HOT Questions for Sessions 1 and 2

Treatment					Comparison				
Participant	Session			Sign	Participant	Session			Sign
	1	2	1-2			1	2	1-2	
T01	2	2	0	NA	C01	0	0	0	NA
T02	4	3	1	+	C02	0	0	0	NA
T03	2	3	-1	-	C03	0	0	0	NA
T04	3	5	-2	-	C04	0	0	0	NA
T05	3	4	-1	-	C05	0	0	0	NA
T06	2	2	0	NA	C06	0	1	-1	-
T07	2	1	1	+	C07	0	0	0	NA
T08	0	2	-2	-	C08	0	1	-1	-
T09	0	0	0	NA	C09	0	0	0	NA
T10	3	4	-1	-	C10	2	0	2	+
T11	0	3	-3	-	C11	0	0	0	NA
T12	2	0	2	+	C12	0	0	0	NA
T13	0	0	0	NA	C13	0	0	0	NA
T14	1	2	-1	-	C14	0	0	0	NA
T15	0	1	-1	-	C15	0	0	0	NA

Table 23

Matched Pair Sign Test Procedure for HOT Questions for Sessions 2 and 3

Treatment					Comparison				
Participant	Session			Sign	Participant	Session			Sign
	2	3	2-3			2	3	2-3	
T01	2	4	-2	-	C01	0	0	0	NA
T02	3	1	2	+	C02	0	0	0	NA
T03	3	2	1	+	C03	0	0	0	NA
T04	5	1	4	+	C04	0	0	0	NA
T05	4	2	2	+	C05	0	0	0	NA
T06	2	3	-1	-	C06	1	0	1	+
T07	1	2	-1	-	C07	0	0	1	+
T08	2	1	1	+	C08	1	2	-1	-
T09	0	1	-1	-	C09	0	0	0	NA
T10	4	2	2	+	C10	0	0	0	NA
T11	3	2	1	+	C11	0	0	0	NA
T12	0	2	-2	-	C12	0	0	0	NA
T13	0	1	-1	-	C13	0	0	0	NA
T14	2	2	0	NA	C14	0	0	0	NA
T15	1	3	-2	-	C15	0	0	0	NA

Table 24

Matched Pair Sign Test Procedure for HOT Questions for Sessions 1 and 3

Treatment					Comparison				
Participant	Session			Sign	Participant	Session			Sign
	1	3	1-3			1	3	1-3	
T01	2	4	-2	-	C01	0	0	0	NA
T02	4	1	3	+	C02	0	0	0	NA
T03	2	2	0	NA	C03	0	0	0	NA
T04	3	1	2	+	C04	0	0	0	NA
T05	3	2	1	+	C05	0	0	0	NA
T06	2	3	-1	-	C06	0	0	0	NA
T07	2	2	0	NA	C07	0	0	0	NA
T08	0	1	-1	-	C08	0	2	-2	-
T09	0	1	-1	-	C09	0	0	0	NA
T10	3	2	1	+	C10	2	0	2	+
T11	0	2	-2	-	C11	0	0	0	NA
T12	2	2	0	NA	C12	0	0	0	NA
T13	0	1	-1	-	C13	0	0	0	NA
T14	1	2	-1	-	C14	0	0	0	NA
T15	0	3	-3	-	C15	0	0	0	NA

Once the researcher calculated the sign quantities from each of the matched pair Sign test procedures for each treatment and comparison group member, significance for the tests were calculated using an online binomial distribution calculator (Sign Test: Binomial Distribution Calculator, 2017). Table 25 indicates that the treatment group showed statistically significant changes in performance in creating HOT questions across all sessions (1 and 2, 2 and 3, and 1 and 3), while the comparison group had no significant differences between any sessions.

Table 25

Matched Pair Sign Tests Results

Group	Pairwise Session Comparisons	Significance
Treatment	Session 1 to Session 2	$p = .002$
	Session 2 to Session 3	$p = .005$
	Session 1 to Session 3	$p = .002$
Comparison	Session 1 to Session 2	$p = .135$
	Session 2 to Session 3	$p = .135$
	Session 1 to Session 3	$p = .095$

Visualizing Performance

In Figure 4, it is evident that at the start of the semester both the treatment and the comparison groups were equivalent in the amount of K/C questions created during the first session. However, there is a distinct drop-off in K/C questions for the treatment group in sessions two and three. This is likely due to their limited session time being used for initiating higher-order questions during their lesson presentations.

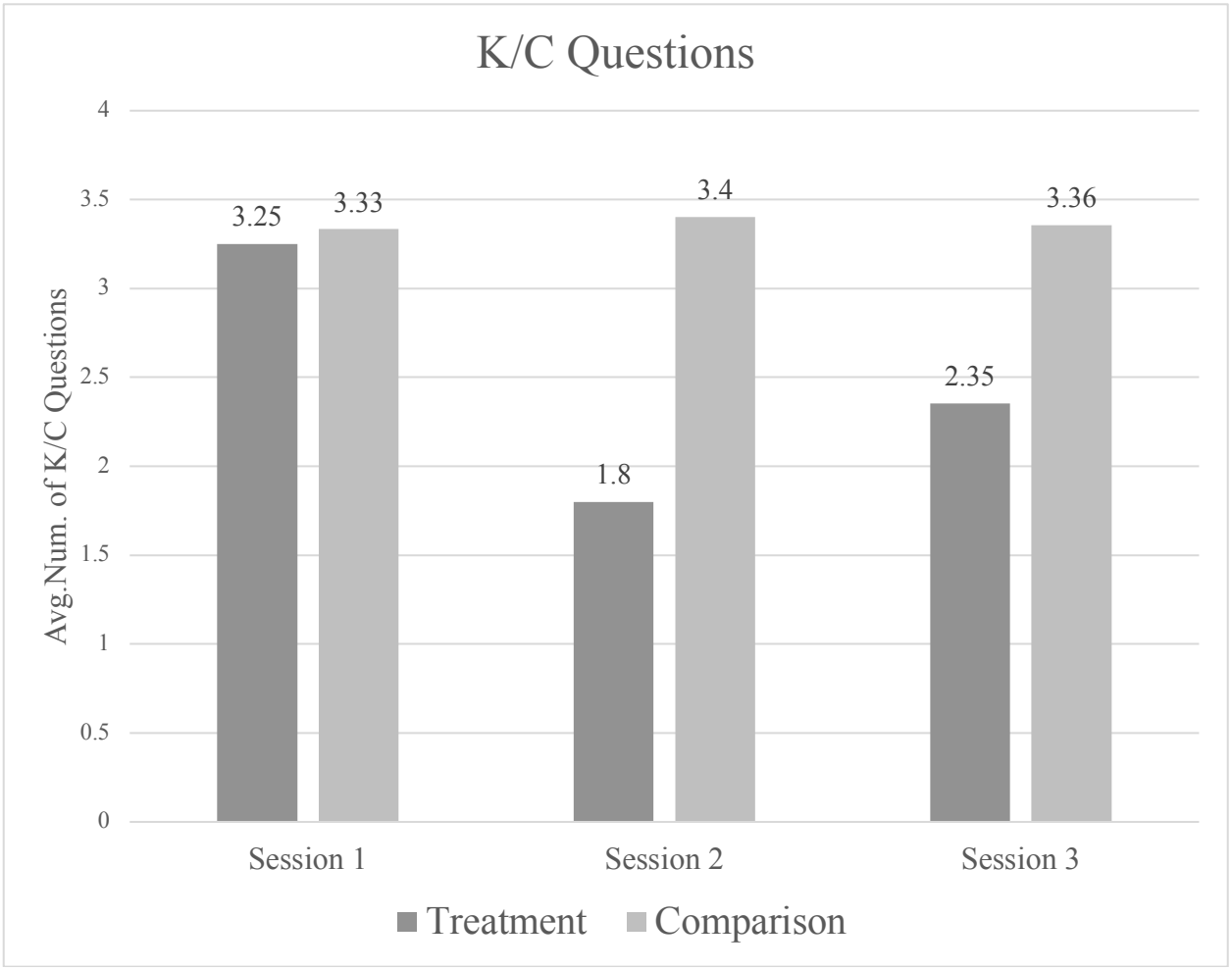

Figure 4. Average number of K/C questions per session, and condition. There were 15 participants in the Treatment Group and 15 in the Comparison Group.

In Figure 5 there is a gradual increase in the average number of HOT questions the treatment group produced. This did not change too much from session 1 to session 3 because of the limited amount of time available for each session (10 minutes). The comparison group's average stayed at a low level. They were asking mostly K/C questions in their lessons.

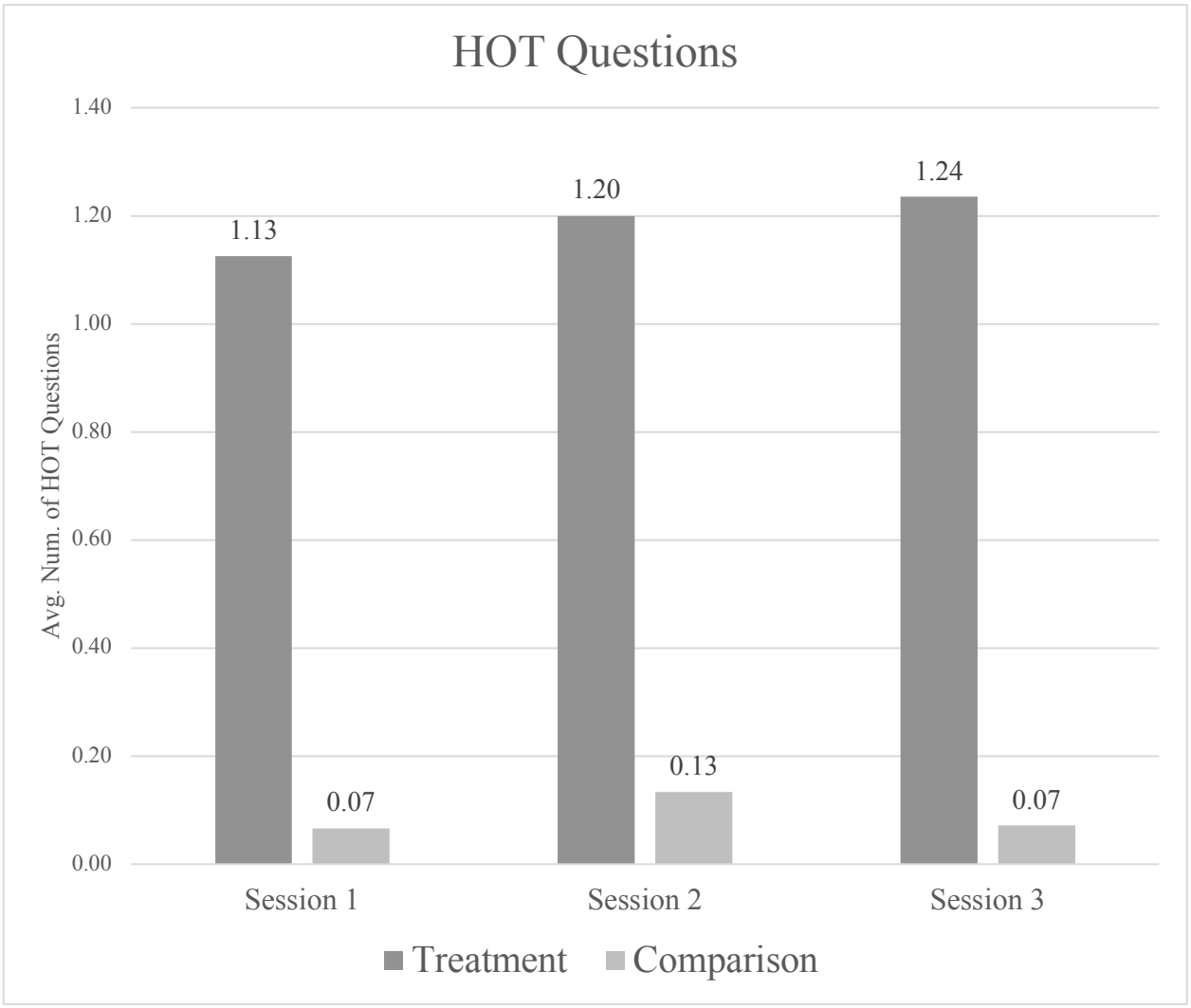

Figure 5. Average number HOT questions per session, and condition. There were 15 participants in the Treatment Group and 15 in the Comparison Group.

Figure 6 provides a graph of the distribution of higher-order question levels between the sessions for the treatment group. In moving from session one to two the treatment group was able to move their higher-order questions from level 1 to level 2 with some even reaching level 3. In the third session, there was a reduction in level 2 HOT questions. There is no figure for the comparison group's HOT questions because the few HOT questions generated were all at level one.

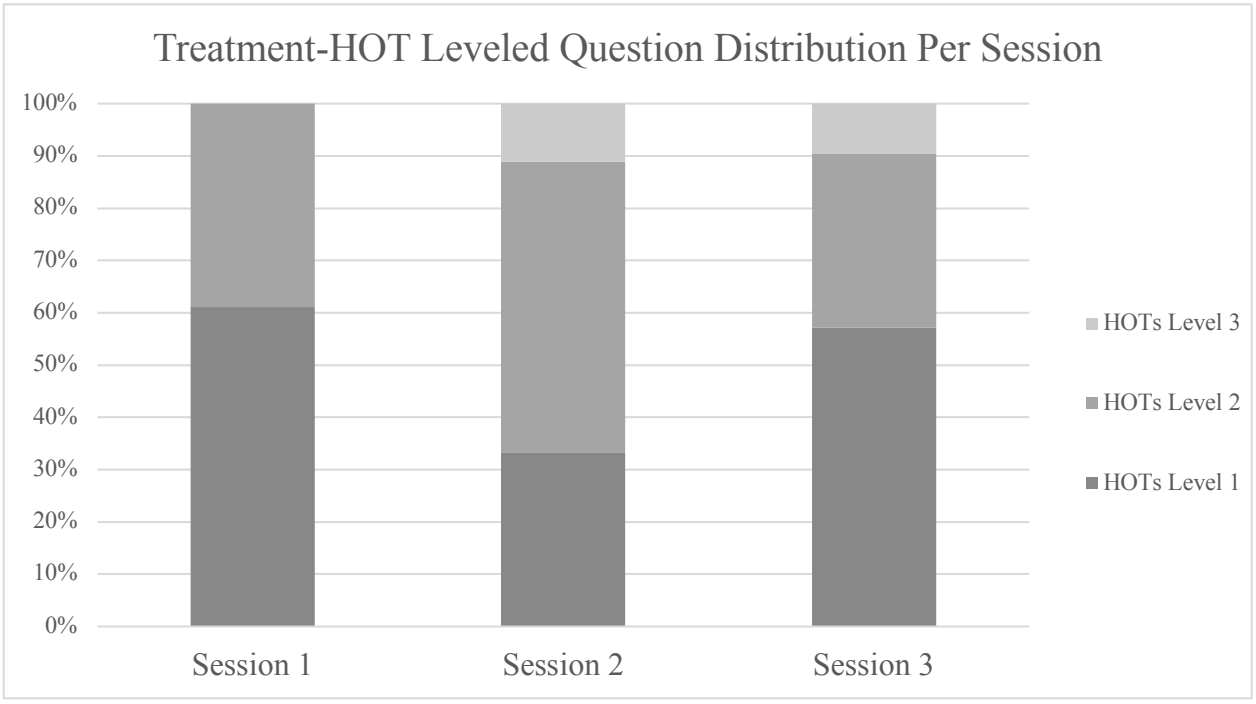

Figure 6. Treatment group HOT question level distribution per session. There were 15 participants in the Treatment Group and 15 in the Comparison Group.

Ratios of K/C and HOT Questions for Each Session

The researcher calculated the average ratios of K/C and HOT questions generated by each group (treatment and comparison). Refer to Figure 7. In session one, the ratio between K/C and HOT questions was 3.2 K/C per 1.13 HOT for the treatment group. This ratio changed to 1.80 K/C per 1.20 HOT for session two and 2.47 K/C per 1.27 HOT for session three. For the treatment group members, there was little change in the ratio of HOT questions between sessions

two and three. The comparison group generated an average of 3.33 to 3.40 K/C questions per session. The ratio between K/C and HOT questions was 3.33 K/C per .07 HOT, 3.40 K/C per .13 HOT, and 3.36 K/C per .07 HOT for sessions 1, 2, and 3, respectively. To explore these results in more depth, the researcher examined the attributes of the HOT questions the treatment and comparison group participants used in their lessons.

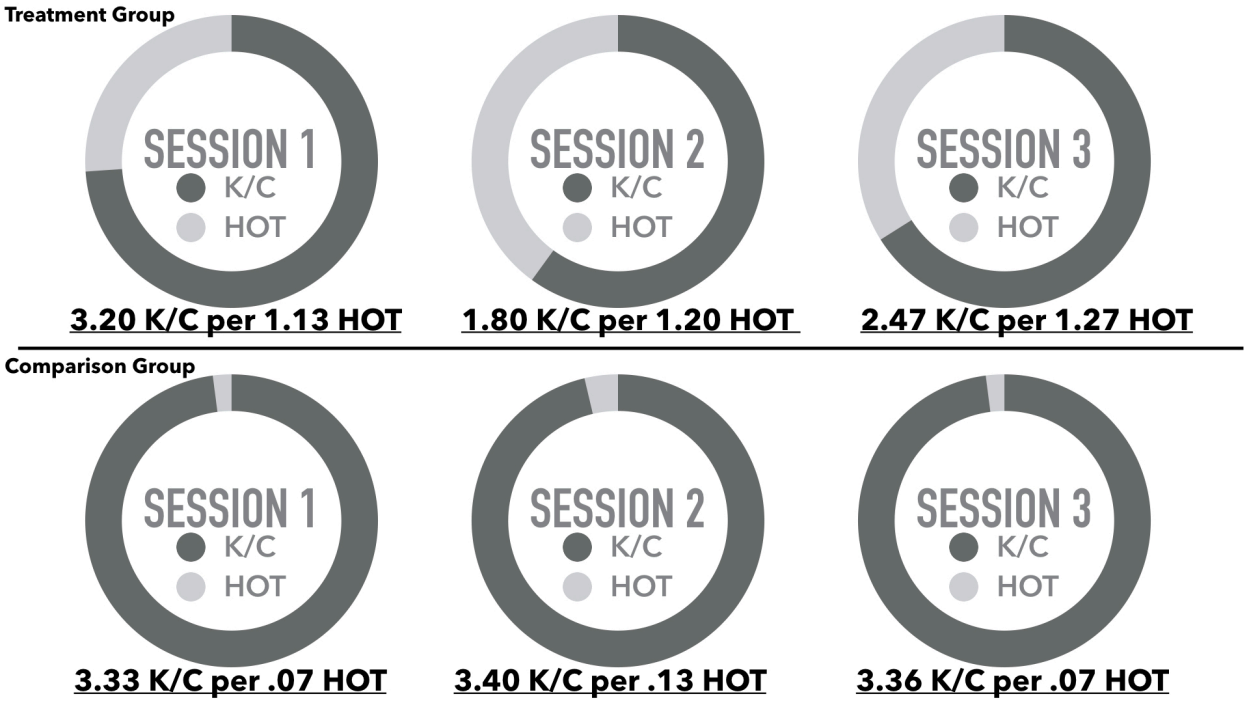

Figure 7. Ratios for K/C and HOT question averages for the treatment and comparison groups per session.

Leveling the HOTs Questions

In Figure 8, the HOT questions were categorized on a scale of 1 to 3 in terms of how the candidate used best practices in implementing HOT questions in his or her lesson. The following criteria were used to assign one of three levels to each HOT question: (a) used HOT question in a lesson, (b) provided wait time and wrote or discussed a response, (c) initiated meaningful dialogue with student(s).

1. Level 1 is represented when the participant asked a higher-order thinking question in the lesson, however, the candidate gave little or no wait time to the students to answer the question and continued the lesson, resulting in no response or dialogue.

   Example HOT question from data: What would life be like if the world was still like Pangea?

   Classification of Level 1: HOT question asked, no wait time, no response or dialogue
2. Level 2 questions were identified when the teacher candidate created and used a higher-order thinking question in the lesson and gave wait time for the students to compose a response. This included the students' writing a response or discussing a response with a class partner. However, the teacher candidate did not engage the students fully in the concept or task that was addressed in the HOT question.

   Example HOT question from data: How would you get past your own bias when writing a persuasive essay?

   Classification of Level 2: HOT question asked, time given for each student to record a response, no follow-up for discussion or engagement.
3. Level 3 questions were identified when the teacher candidate created and used a higher-order thinking question in the lesson, provided adequate time for the students to compose a response, and engaged the students in meaningful dialogue drawing out conclusions and thoughts related to the question.

   Example HOT question from data: Why do we know about old inventors but we do not know about new inventors?

   Classification of Level 3: HOT question asked, time given for each student to record a response, prompted extensive discussion between students.

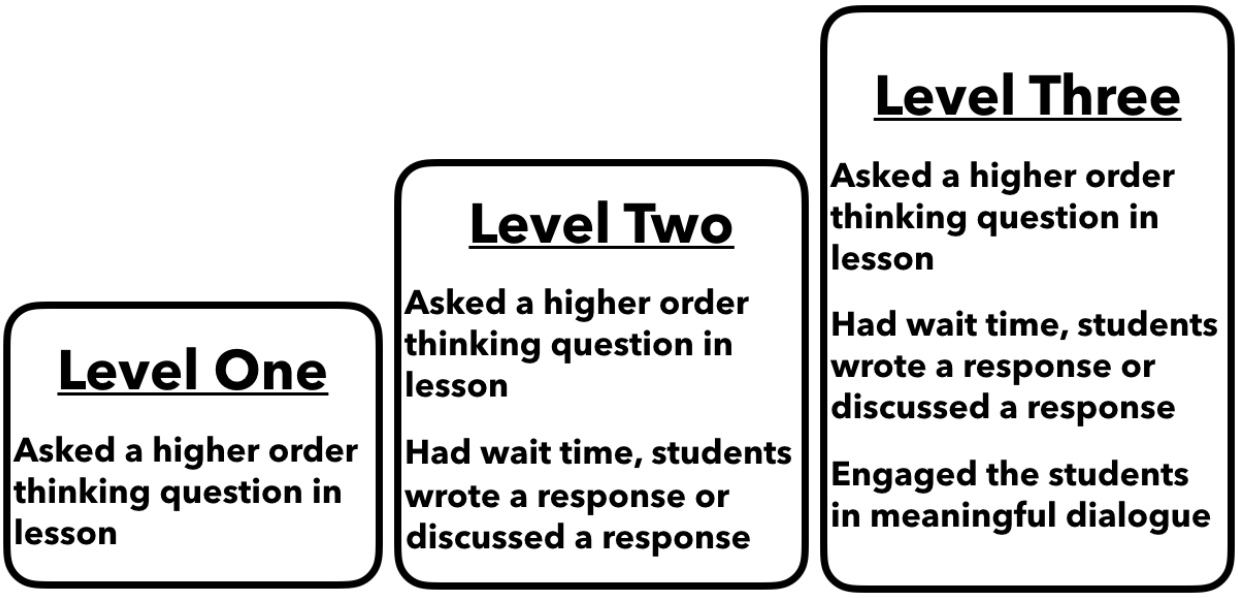

Figure 8. Criteria for leveling HOT questions.

Before the first mixed-reality simulation session the researcher coached the treatment group on the basics of HOT questions and how to use them in a lesson. After each lesson presentation, the researcher reviewed the video for each participant and produced a report of the performance data regarding each question posed during the lesson. This data-driven feedback was connected to the coaching given by the researcher. In Table 26, one can see that in the first session, the treatment group's questions were distributed between HOT question Levels 1 and 2, with the majority being Level 1. In the second and third sessions, the treatment group's questions were distributed between HOT question Levels 1, 2 and 3. This means the members of the treatment group shifted toward using the higher leveled HOT questions in the final two sessions. However, the overall ratio of K/C and HOT questions had little change between these two sessions. The researcher believes this is due to the limited amount of time for the session (10 minutes) and the increase in time it takes the preservice teacher to use higher level HOT questioning practices. The higher level HOT questions took longer, when performed correctly,

and left less time for K/C questions. Table 27 reveals the few HOT questions posed by comparison group members across sessions.

Table 26

Treatment Group Question Performance for Each Session

Participant	Session One Questions					Session Two Questions					Session Three Questions				
	K/C	HOT Level 1	HOT Level 2	HOT Level 3	Total HOT	K/C	HOT Level 1	HOT Level 2	HOT Level 3	Total HOT	K/C	HOT Level 1	HOT Level 2	HOT Level 3	Total HOT
T01	4	0	1	0	1	0	0	1	0	1	1	2	1	0	3
T02	4	0	2	0	2	3	1	1	0	2	3	1	0	0	1
T03	3	2	0	0	2	1	0	0	1	1	2	0	1	0	1
T04	3	1	1	0	2	0	0	1	1	2	1	1	0	0	1
T05	4	3	0	0	3	0	0	2	0	2	1	0	1	0	1
T06	2	0	1	0	1	2	0	1	0	1	0	0	0	1	1
T07	3	0	1	0	1	2	1	0	0	1	2	0	1	0	1
T08	5	0	0	0	0	2	0	1	0	1	3	1	0	0	1
T09	2	0	0	0	0	3	0	0	0	0	3	1	0	0	1
T10	2	1	1	0	2	0	2	1	0	3	3	2	0	0	2
T11	4	0	0	0	0	2	1	1	0	2	4	2	0	0	2
T12	3	2	0	0	2	4	0	0	0	0	4	0	1	0	1
T13	2	0	0	0	0	5	0	0	0	0	3	1	0	0	1
T14	4	1	0	0	1	1	0	1	0	1	2	0	1	0	1
T15	3	0	0	0	0	2	1	0	0	1	5	0	0	1	1
Total	48	10	7	0	17	27	6	10	2	18	37	11	6	2	19
Average	3.20	1.67	1.17	0	1.13	1.80	1.20	1.11	1.00	1.20	2.47	1.38	1.00	1.00	1.27
Ratio	3.20 K/C: 1.13 HOT					1.80 K/C: 1.20 HOT					2.47 K/C: 1.27 HOT				

Table 27

Comparison Group Question Performance for Each Session

Participant	Session One Questions					Session Two Questions					Session Three Questions				
	K/C	HOT Level 1	HOT Level 2	HOT Level 3	Total HOT	K/C	HOT Level 1	HOT Level 2	HOT Level 3	Total HOT	K/C	HOT Level 1	HOT Level 2	HOT Level 3	Total HOT
C01	5	0	0	0	0	4	0	0	0	0	3	0	0	0	0
C02	6	0	0	0	0	5	0	0	0	0	5	0	0	0	0
C03	2	0	0	0	0	3	0	0	0	0	4	0	0	0	0
C04	1	0	0	0	0	4	0	0	0	0	3	0	0	0	0
C05	5	0	0	0	0	2	1	0	0	1	4	0	0	0	0
C06	3	0	0	0	0	2	0	0	0	0	2	0	0	0	0
C07	4	0	0	0	0	5	1	0	0	1	4	0	0	0	0
C08	2	0	0	0	0	2	0	0	0	0	1	0	1	0	1
C09	4	0	0	0	0	4	0	0	0	0	NA	NA	NA	NA	NA
C10	1	0	1	0	1	4	0	0	0	0	5	0	0	0	0
C11	4	0	0	0	0	3	0	0	0	0	3	0	0	0	0
C12	5	0	0	0	0	4	0	0	0	0	4	0	0	0	0
C13	4	0	0	0	0	3	0	0	0	0	4	0	0	0	0
C14	3	0	0	0	0	3	0	0	0	0	3	0	0	0	0
C15	1	0	0	0	0	3	0	0	0	0	2	0	0	0	0
Total	50	0	1	0	1	51	2	0	0	2	47	0	1	0	1
Average	3.33	0	.13	0	.07	3.40	1	0	0	.13	3.36	0	1	0	.07
Ratio	3.33 K/C:.07 HOT					3.40 K/C: .13 HOT					3.36 K/C: .07 HOT				

Research Question Three

What are the perceptions of preservice teachers' abilities and experiences in using a mixed-reality simulation where one group receives data-driven feedback and coaching throughout a semester about their performance scores for the number and types of questions they ask while teaching lessons and the other does not?

Types of Data Collected and Analyses Employed

Research question three is qualitative in nature and was analyzed using a case-study approach (Creswell & Clark, 2011). A separate case study was performed for each group in the study (treatment and comparison). The treatment-group case study included three coaching sessions and a final interview; all of these phone conversations were audiorecorded. The comparison group's case study contained only the final phone interview. Once the coaching sessions and interviews were transcribed, a summative content analysis was used to gain information from participants' responses. Summative content analysis codes were developed from keywords and phrases. These keywords and phrases were chosen based on the interest of the researcher and from reviewing the literature (Saldaña, 2016). Because these data were collected without a framework, this research used emerging inductive codes that can allow findings to emerge from the data (Saldaña, 2016).

Using Saldaña's (2016), 35 codes were developed which were collapsed into four main themes: (a) data-driven feedback and coaching improves self-efficacy (treatment only), (b) planning for a lesson requires reflection, (c) lesson performance enhanced by reflection, and (d) data-driven feedback and coaching improves questioning skills. All codes and their frequencies were reported in tables grouped by their codes and theme. The code frequencies were compared

between treatment and comparison groups to gain insight into the difference between participants' perceptions of their abilities and experiences.

Results from the Facilitator Coaching for the Treatment and Comparison Groups

Stated earlier in chapter three, during mixed-reality simulation sessions each preservice teacher candidate presented his or her lesson in a room with a simulation facilitator. The facilitator made sure the simulation is working properly, monitored time so that each student stayed on schedule, and gave short feedback after each candidate has taught his or her lesson. This short feedback can cover any topic the facilitator feels is important to address. It is also important to note, due to time constraints during the simulation process, several participants received very brief or no feedback from the facilitator.

Table 28 shows that both groups felt the in-class feedback from the simulation facilitator was helpful, however, some reported not receiving feedback, or not remembering it. Some participant comments related to not getting any feedback. These included, "I really didn't get any feedback from the professors that were in the room, so, I really didn't have anything to really change my next teaching session" (C09), and "I would go towards the end most of the time, so generally, I didn't really get feedback" (T03). Members of the comparison group voiced concern that the goals of the lessons were unclear, and they wished they had more guidance. Some members of the comparison group recommended a system resembling that received by the treatment group. While they did not indicate being aware of the treatment procedures, some participants remarked about receiving one-on-one coaching in other classes and recommended it for the simulation sessions. Samples of their comments in regard to the code, lesson goals were unclear and the code, wanted more guidance, included "parameters were always so vague so I would usually not think of something until the day of" (C02) and "I think if you had a one-to-one

meeting afterwards, if that were possible, yeah . . . that would be beneficial, hearing especially personalized comments from the pro." (C05)

Table 28

Frequency of Codes for the Theme Three: Facilitator Feedback

Facilitator Coaching/Codes	Treatment	Comparison
Positive facilitator coaching comments		
Felt facilitator feedback was helpful	15	17
Used facilitator feedback	0	5
Concerns regarding facilitator coaching		
Goals for lesson were unclear	NA	14
Wanted more guidance	NA	32
Did not remember in-session facilitator feedback	2	5
Did not use facilitator feedback	1	5
Did not receive any facilitator feedback	0	3
Wanted more facilitator feedback	2	6
Felt facilitator feedback was not helpful	1	2

Note. There were 15 participants in the Treatment Group (data-driven feedback and coaching) and 14 in the Comparison Group (no data-driven feedback and coaching).

Results from Data-Driven Feedback and Coaching Sessions for the Treatment Group

Theme One: data-driven feedback and coaching improves self-efficacy (treatment only). During the coaching phone calls the researcher's main objective was to generate data-driven feedback and suggestions for improving the next lesson. Refer to Appendix D for the coaching protocol. The researcher also used this opportunity to code his feedback continuity throughout all three sessions in order to self-check if the coaching session procedure was

followed. For a list of these codes and their frequencies, see Appendix F. In Table 29, insights can be gained from the codes that emerged from the coaching sessions. After the first coaching session, every member of the treatment group stated that he or she appreciated the one-to-one aspect of the coaching and stated that the coaching had a positive effect on his or her lesson performance. Treatment participant 14 (T14) stated, "It's really making it a lot easier having someone to talk to about it . . . and to be able to discuss it afterwards to see where we can see what needs to improve." T01 also affirmed, "the first phone call really helped me because I really didn't understand what we had to do with the higher-level thinking questions, so that helped a lot." Participants commented on how using HOT questions was a positive experience in their lesson. T06 said, "My higher-level thinking question [about] whether exercise or [healthy] eating had a greater impact on your body . . .. I felt they responded to that." T12 stated his belief that the coaching was helpful when he stated, "I feel like you have to ask them a question (HOT) at least that will get them to critically think about what you're asking them . . . to get the kids to talk." At the end of each of the three coaching sessions most members of the treatment group felt confident in preforming the next lesson.

Table 29

Frequency of Codes from the Treatment Group's Coaching Sessions

Categories Related to Self-Efficacy/Codes	Session 1	Session 2	Session 3
Mastery of experiences			
Expresses confidence in "doing a lesson"	0	10	11
Develops clearer questioning goals after coaching session	2	9	15
Believes the simulation is a positive experience	6	8	3
Amount or type of social encouragement received			
Acknowledges coaching had a positive effect on lesson implementation	0	23	21
Appreciates one-on-one coaching	0	15	15
The individual's responses to stressors			
Connects questioning to good teaching practices	5	17	19
Displays low confidence in performing the lesson	3	1	1

Note. There were 15 participants in the Treatment Group (data-driven feedback and coaching).

Treatment-group members indicated that they felt all aspects of the coaching they received were positive and helpful in their development. Refer to codes in Table 30. Members of the treatment group made comments about having received useful advice. One participant said, "I thought it was definitely more helpful . . . it was more based on you and then you got to more specifics and it was like advice that you could actually use" (T09). This one-on-one coaching helped them to plan their lessons as expressed by this participant when she stated, "Oh, I thought this was very helpful [the coaching] as well because we're actually talking about it . . .

it's just very structured [data-driven feedback]" (T04). Teaching candidates stated that the data feedback helped them to reflect on their performance and shape their next lesson. This sentiment was exemplified by this coed who said, "The feedback in the phone calls has been absolutely amazing and a tremendous help because I would have honestly beaten myself up for the whole [time] . . . what you told me is so helpful and just like let it go and realizing that I can do a lot better and that I can recover from it" (T13). Some members of the treatment group requested the treatment style of coaching for the next semester.

Table 30

Frequency of Codes for the Final Interview (Treatment only)

Categories Related to Self-Efficacy/Codes	Treatment
Mastery of experiences	
Positive effect on planning for a lesson	19
Positive effect on personal reflection	15
Amount or type of social encouragement received	
Received useful advice	19
Positive effect on overall performance	22
Requested that coaching continue	7

Note. There were 15 participants in the Treatment Group (data-driven feedback and coaching).

Results from the Interviews

At the end of the semester, the researcher conducted a 10- to 15-minute telephone interview with all members of the treatment and comparison groups. The interview questions were:

1. How do you think your teaching has changed during this past semester?
2. What did you do to prepare for each TeachLivE lesson? Where did get your ideas from?
3. What could have helped you to be better prepared?
4. What was your planning strategy to develop a lesson that would engage students in higher-order thinking? Do you think you asked appropriate questions to engage students in higher-order thinking? (look at lesson notes)
5. Did anything about the students' responses change the way you taught your lesson? Did you teach your entire lesson every time? What changed the way you taught?
6. What are your thoughts on the coaching (feedback) given after each TeachLivE session?
7. Did the coaching effect your TeachLivE lesson? If so how?
8. Are you satisfied with your performance TeachLivE sessions this semester? What do you think about TeachLivE as a teacher training tool?
9. What feedback or resources would have been helpful? What advice would you give to a student just beginning this course?
10. How can we improve this experience in the future?

Theme Two: planning for a lesson requires reflection. In Table 31, the responses of the treatment group indicate that these participants implemented more planning time while constructing their lessons than their comparison group counterparts for the mixed-reality simulation sessions. The treatment group added questions into their lesson as a result of the data-driven feedback and coaching sessions. Members of the treatment group made comments, such as,

> I drew different ideas and different questions from . . . different lessons to kind of make up my own [questions] and then I also developed the answers to the questions myself, just in case. (T03)
>
> I was trying to find my own ways to connect [making questions] with the students. (T05)
>
> I had no idea how to teach any of that, I didn't have any of the answers to most of the questions…just see where the students take me. (T15)

The comparison group members were less likely to modify their planning after receiving the post session feedback from the simulation facilitator. They expressed comments such as this statement from comparison group member C11, "I would write a little bit of a script . . . usually an introduction that I would stick with almost word for word." Another group member, C04, commented, "I don't know, I sort of just kind of thought of what music elements that worked best with the avatars because they obviously can't do everything." Preservice teacher C06 also noted limitations of working with the avatars and her own lack of confidence when she said, "I kind of worked around what I knew that they could do and then I wrote down exactly what I wanted to say and then I kind of completely ditched it whenever I got in front of them."

Table 31

Frequency of Codes for Theme Two: Planning for a Lesson Requires Reflection

Categories Related to Reflection/Codes	Treatment	Comparison
Engaged in reflective practices		
Increased lesson planning time after each session/feedback	29	10
Added questions to lessons after session/feedback	22	1
Did not engage in reflective practices		
Did not consider adding questions to the next lesson to improve his or her performance	0	10
Did not change any planning strategies after a session	2	12
Did not plan for the simulation lesson	0	2
Engaged in reflective practices, however did not use opportunity to meet needs of simulated student		
Believed he or she had to modify the lesson to accommodate the limitations of the simulated student	3	11

Note. There were 15 participants in the Treatment Group (data-driven feedback and coaching) and 14 in the Comparison Group (no data-driven feedback and coaching).

Theme Three: lesson performance is enhanced by reflection. Table 32 indicates that the treatment-group members felt they had improved in their lessons and interactions with the avatar students throughout the semester. In their comments they explained how their students seemed more on task and that they could get through their content more smoothly. Sample comments include,

> CJ and Maria really like reading and I just take . . . the individual personality and try to find a way to incorporate it all in one lesson so that they're all engaged. (T15)

> I feel [that] the classroom management, lesson, and . . . my organization of the lesson has gotten better. (T07)
>
> I feel like they didn't fool around as much because they were thinking about the questions. (T08)

The treatment group also had fewer perceived issues adapting to avatar interactions than did the comparison group. The members of the comparison group made comments about adapting to the simulated students, which included,

> I shouldn't say I broke it, but because the SIMS were not able to accurately participate because they couldn't sing. (C10)
>
> So, I feel like through TeachLivE I've not only . . . developed lesson plans differently but it's a lot different teaching for [real] students. (C08)

It is also worth noting that the majority of the comparison-group members did not feel they improved in their lesson performance throughout the semester, as indicated by this comment: "I don't think it's changed a ton. I think maybe like classroom management got a little better, maybe that's better" (C06). Despite the fact that this was the third semester for these preservice teachers to engage with the mixed-reality simulation, some members of the comparison group noted that it was difficult to plan for the designated lesson time. This was noted by comparison group member C09: "I've left a couple of the TeachLivE lessons thinking I ran out of time or I didn't reach all the points I wanted to," and "There were times where I wish I had a little more time, but also times where I wish I had a little less time."

Table 32

Frequency of Codes for Theme Three: Lesson Performance Enhanced by Reflection

Categories Related to Reflection/Codes	Treatment	Comparison
Engaged in reflection-in-action		
Adapted to unplanned interactions in the lesson caused by avatars	29	8
Did not engage in reflection-in-action		
Encountered issues adapting to unplanned interactions in the lesson caused by avatars	9	19
Engaged in critical reflection		
Believed avatars responded well to lesson	19	1
Performance improved over the semester	30	4
Did not engage in critical reflection		
Lesson performance unchanged over the semester	0	10
Weaker teaching performance compared to prior semesters using the simulation	0	10

Note. There were 15 participants in the Treatment Group (data-driven feedback and coaching) and 14 in the Comparison Group (no data-driven feedback and coaching).

Theme Four: data-driven feedback and coaching improves questioning skills. In Table 33, the responses of the treatment-group participants indicated they felt their ability to create and use higher-order questions in their lessons had increased during the semester. Their comments included:

> Well I feel like I've explored more with the whole higher-order thinking questions. I didn't really ever put much thought into that before this semester. (T01)

> Going from asking questions where I had the specific answer in my head to asking questions to see what they would think . . . it was smoother in being able to communicate the questioning and have the kids as engaged as possible. (T13)
>
> I think it was effective and I think that was shown in my assessment [from the coach's feedback] on the last session when I reflected on the first session, all the kids were able to tell me what they did and their answers came a long way from the first session. (T03).

In contrast, many members of the comparison group felt their overall questioning skills were unchanged. In their comments, they made little to no mention of their growth in question creation through statements such as the following,

> I didn't always get to them [the questions] because of the way I structured my lesson for the amount of time we had. (C15)
>
> I don't think I did it was well as I could have, but I think I was kind of confused on the higher-order thinking. (C06)

During the interviews, most of the comparison-group members seemed uncertain on the definition, usage, and creation of higher-order questions. Their comments for the code Unclear about the definition of HOT questions, included,

> Higher-order thinking, well again that's a little more difficult with music because we really don't use higher-order thinking questions. (C14)
>
> I think it's more so that the way I did it I taught the content first and then I kept asking questions to see if they understood the content. (C06)
>
> It's hard to plan for higher-order thinking . . . it can only come naturally. (C10)

Because of this lack of understanding of HOT questions, one can understand why so few HOT questions were presented during each lesson delivered by comparison-group members.

Table 33

Frequency of Codes for Theme Four: Questioning Skills

Categories Related to Self-Efficacy/Codes	Treatment	Comparison
Mastery of experience-Questioning skill growth		
HOT creation skills improved	27	0
Overall HOT questioning skills improved	27	1
Mastery of experience-Questioning skill lack of growth		
Overall questioning skills were unchanged	0	9
Unclear about the definition of HOT questions	0	13
HOT student generated content		
Avatars created HOT questions from their lessons	2	0

Note. There were 15 participants in the Treatment Group (data-driven feedback and coaching) and 14 in the Comparison Group (no data-driven feedback and coaching).

Chapter Summary

The purpose of this research was to study the effect of data-driven feedback and coaching on preservice teachers in regard to their questioning skills as they prepared and taught lessons using a mixed-reality simulation environment. After it was found that there was no significant difference between the mean GPAs of treatment- and comparison-group members, the three research questions were addressed. The first question (quantitative) explored the participants' (treatment group and comparison group) general teaching self-efficacy by comparing their mean pretest and posttest scores from the TSES. For the pretest scores, there were no statistically significant differences between the treatment and comparison group means as determined by an ANOVA, $F(1,28) = 2.94$, $p = 0.10$. An analysis of the posttest scores using an ANCOVA indicated that there were no statistically significant differences between the treatment and

comparison groups regarding a total score on the TSES, after covarying for initial differences in pretest scores, $F(1,26) = 0.66$, $p = 0.42$. The second question, which was quantitative, explored statistically significant differences in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, in which one group received data-driven feedback and coaching about their performance scores and the other group did not. A Chi-Square procedure and Sign test were used to analyze these data. The Chi-Square analysis showed a significant difference between questioning performance between the treatment and comparison groups using an *a priori* p-value of 0.05, ($\chi^2(1) = 47.56$, $p < .01$). The Sign test showed statistically significant change in performance in creating HOT questions across all sessions (1 and 2, 2 and 3, and 1 and 3) for the treatment group, while the comparison group had no significant differences between any sessions. Lastly, the third question was qualitative in nature. Transcripts of the treatment group's coaching sessions and end of study interviews with all participants where used to create codes from keywords and phrases. Those codes where analyzed and formed four themes. The themes were: (a) data-driven feedback and coaching improves self-efficacy, (b) planning for a lesson requires reflection, (c) lesson performance is enhanced by reflection, and (d) data-driven feedback and coaching improves questioning skills. Code frequencies within these themes were then compared between treatment and comparison groups to gain insights into the participants' perceptions of the experience.

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

Chapter five provides a summary of the results and conclusions pertaining to this research study. The purpose of this mixed methods study was to explore the impact of data-driven coaching on preservice teachers who used a mixed-reality classroom simulation in a teacher-preparatory program. The chapter has been divided into six main sections. First is a synopsis of the research process. Then, each of the three research questions contain the following sections: (a) the research question, (b) results for that question, (c) relation of research question to the literature, and (d) suggestions for Future Research. The chapter closes with, program recommendations, limitations of the study, and the conclusion.

Synopsis of Research Process

Setting

The participants were undergraduate students in a southern New England state university's preservice teacher-preparatory program. The certification areas for these future teachers included elementary (K-6) and secondary (7-12) education. All elementary education students were learning to teach the four main content subjects of language arts, mathematics, social studies, and science. The secondary education students focused on the topics of mathematics, music, health, and chemistry. The participants were enrolled in two sections of the same preservice teaching course, a mix of sophomores and juniors, who were scheduled to participate in three 10-minute sessions with mixed-reality simulations distributed throughout the semester. Each simulated lesson needed to target the high-leverage practice of higher-order thinking through the use of questioning skills (Piro & O'Callaghan, 2016). All students in both sections were at similar points in their programs of study, and the same professor taught both sections.

Research Design

This research was conducted using a mixed-methods embedded design where the researcher collected both quantitative (main component) and qualitative (secondary component) data. The quantitative portion used a quasi-experimental design where one course section acted as the treatment group, receiving data-driven feedback and coaching before all three of the mixed-reality simulator sessions and the compassion group did not (Gall, Gall, & Borg, 2006). Data about questioning were collected from each session by the researcher. Also, all the participants completed the Teacher Self-Efficacy Survey (TSES) at the start of the semester and again at the end of the semester. The secondary qualitative portion employed a qualitative methodology in the form of a case study (Creswell & Clark, 2011). A separate case study was performed for each group in the study (treatment and comparison). The treatment group case study included three coaching sessions, each of these had the audio (phone call) recorded and a final interview, also having the audio (phone call) recorded. The comparison group's case study contained only the final phone interview with the audio recorded. All recordings were later transcribed and coded to gain understanding of the experiences of each participant.

Mixed-Reality Simulation Procedure

During mixed-reality simulation sessions all preservice teacher candidates from a particular course section were present in the room with a simulation facilitator as students took turns to present their lessons. The facilitator made sure the simulation was working properly, video-recorded each presentation, monitored the time for each lesson presentation, and gave short feedback after each candidate finished presenting a lesson. Since all candidates from a course section were present during each lesson, these classmates were able to make comments or suggestions to the participant who just preformed a lesson.

Implementation of the Study

Course sections were randomly assigned to either treatment or comparison condition. Individuals in both the treatment and the comparison groups completed the three lesson presentations with the mixed-reality simulator. There were 15 participants in the comparison group, the treatment group originally had 17 participants but two were removed due to non-completion of all three sessions. This resulted in 15 members in the treatment group. Additionally, those in the treatment group received individual data-driven feedback about the number and the types of questions (K/C and HOT) posed and coaching from the researcher, via phone, about: (a) the number and types of questions asked in a prior teaching session, (b) the development of questions used during a lesson, and (c) the formation of a plan to improve higher-order questioning techniques in a future lesson. Each coaching session took place one to three days after the simulated lesson, each phone call lasting between 10 and 20 minutes. A final phone interview was conducted for 10-15 minutes with each member of the treatment and the comparison group. This interview included topics of lesson preparation, performance, and perceptions of the simulation experience.

Research Question One

Research Question

Is there a statistically significant difference in preservice teachers' self-efficacy over a semester for candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores for the number and types of questions they ask while teaching lessons and the other does not?

Research Question One Results

Unchanged self-efficacy. The participants in this study were completing their third semester using the mixed-reality simulator. When they were given the pre TSES (Tschannen-Moran & Hoy, 2001) at the start of the semester, both groups scored high (above 6) in self-efficacy (treatment $M = 7.39$ and comparison $M = 6.76$). The scores improved slightly and were also high in the post survey administered at the conclusion of the semester (treatment $M = 7.47$ and comparison $M = 6.98$). An ANOVA between the treatment and comparison groups' TSES pretest scores found no statistically significant difference $F(1,28) = 2.94$, $p = 0.10$, and an ANCOVA found no statistically significant difference between the treatment and comparison groups' TSES posttest scores $F(1,25) = 0.66$, $p = 0.42$. This lack of significance in performance between the groups adds two interpretations to this research. The first addresses the lack of the difference in self-efficacy between the groups despite the fact that the treatment group performed better in creating and using HOT questions in their lessons. The treatment group produced more HOT questions and their self-efficacy was high for the pretest and posttest surveys. The comparison group did not grow in their HOT question production, while they also had high pretest and posttest self-efficacy scores. Both groups had similar high mean scores on the pretest and posttest of the TSES regardless of having the intervention. Thus, the differences in the number of HOT questions generated between the treatment and comparison groups does not appear to be related to the mean self-efficacy scores for either group

The second interpretation from these results concerns the program as a whole and the instrument used. This is the third semester that the participants used the mixed-reality simulator. For most students in this study, this amounted to participation in a total of nine mixed-reality simulations. They had a reasonable amount of familiarity in interacting with the simulator, thus

they entered the semester with high self-efficacy toward teaching in a mixed-reality simulator that was built on past experience with the system. The TSES only measured general teaching skills and did not address the high-leverage practice of using HOT questions in a lesson. This overall lack of focus could also have contributed to the high scores because the participants were asked to reflect on their general practice when responding to TSES items rather than whether they grew in using a new skill.

Relation of research question two to the literature. The second research question addressed in this study was used to explore the difference between the preservice teachers' sense of efficacy between the treatment and comparison group. According to Bandura (1986, 1994, 1997), the types of feedback one receives (from an event, mentor, or reflection) about individual actions performed can impact personal growth in mastering a skill or making decisions. Self-efficacy is the level of certainty in one's individual ability to perform an action or make decisions and achieve the desired results (Bandura, 1994). The dimensions to developing one's self-efficacy related to this study include the mastery of experiences, amount and type of social encouragement received, and how the individual responds to stressors. The most effective method for one to gain self-efficacy in a task or discipline is mastery of experiences (Bandura, 1994), in other words completing tasks that are the same or similar to the intended goals.

The mixed-reality simulator can provide the experiences that connect to the dimensions related to developing one's self efficacy. Having a direct experience in completing a task or controlling an environment will build self-belief in the ability to complete that undertaking. However, there are outcomes that could undermine one's growth in developing self-efficacy. Bandura states, "if people experience only easy successes they come to expect quick results and are easily discouraged by failure. A resilient sense of efficacy requires experience in

overcoming obstacles through perseverant effort" (1994, p. 6). To effectively gain self-efficacy through mastery of experiences requires a balance between experiencing success and overcoming obstacles. In this study, members of both the treatment and comparison groups experienced similar challenges in the simulator. However, the treatment group members were able to experience skill growth during that time because the coach made their success apparent when they overcame the obstacle of creating and using HOT questions in a lesson.

Suggestions for Future Research

The TSES (Tschannen-Moran & Hoy, 2001) in this research measured self-efficacy toward teaching. Means from both groups indicated high scores in the pre and post surveys, regardless of their performance with the high-leverage practice of creating and using HOT questions in a lesson. A suggestion for future research is to perform a similar study with an instrument that can connect preservice teacher self-efficacy to performance in using a specific high-leverage practice, rather than performance in general teaching self-efficacy. This study only followed a single cohort of students through one semester. This was their third semester using the mixed-reality simulator, thus the data for the development of self-efficacy over time was limited. A suggestion for a future study would be to follow a cohort across the entire teacher-preparatory program and collect TSES (Tschannen-Moran & Hoy, 2001) data as well as perspectives of self-efficacy related to specific high-leverage tasks over time. These data could be collected at the start and end of each semester. This could help identify points in the program where students are gaining self-efficacy or encountering setbacks. This information could also be useful to the teacher-preparatory program coordinators for planning coaching and feedback strategies.

Research Question Two

Research Question

Is there a statistically significant difference in the number and types of questions asked over a semester by candidates in a teacher certification program, using a mixed-reality simulation, where one group receives data-driven feedback and coaching about their performance scores and the other does not?

Research Question Two Results

Performance gap between the groups. The treatment group's ability to create and use HOT questions in their simulated lessons completely outpaced the comparison group from the start of the study (the first simulation session) and continued throughout the duration of the study. A two-sample case Chi-Square procedure was conducted where the sum of all leveled HOTs and K/C questions per session was the dependent variable in the analysis and the type of program, feedback and coaching and no feedback and coaching, served as the independent variable (Hinkle et al., 2003). The Chi-Square analysis showed a significant difference between K/C and HOT questioning performance between the treatment and comparison groups. Additionally, all four residuals were important contributors to the Chi-Square value. The number of HOT questions observed by those in the treatment group was 54, which was well above the expected 30.28. However, the number of HOT questions observed for the comparison group was 4, while the expected was 27.72. The observed amount of HOT questions fell extremely short of the expected amount, giving the largest residual in the Chi-Square procedure.

As a follow-up, a Matched pair Sign test procedure was conducted to analyze change between sessions 1 and 2, 2 and 3, and 1 and 3 for the treatment and comparison groups in regard to HOT questions generated. The treatment group showed statistically significant change in

performance in creating HOT questions across all sessions, 1 and 2 (p = .002), 2 and 3 (p = .005), and 1 and 3 (p = .002). The comparison group had no significant differences between any sessions, 1 and 2 (p = .135), 2 and 3 (p = .135), and 1 and 3 (p = .095). Both sections received the same course goals, materials, and amount of simulated classroom sessions. Higher-order thinking questions were part of the course's simulation goals for the participants. However, the comparison group generated very few HOT questions while the treatment group members, who received direct data-driven feedback and coaching, prior to the study and after each lesson presentation, were able to generate HOT questions at varying degrees of complexity. The coaching had the desired effect of having the participants in the treatment group, not only, create and use HOT questions in their three lessons, but improve their performance over the semester.

Observing the ratio of question types per session, members of the treatment group shifted toward using the higher leveled HOT questions in session 2 and 3. They engaged in better questioning practices. In session one, the ratio between K/C and HOT questions was 3.2 K/C per 1.13 HOT. This ratio changed to 1.80 K/C per 1.20 HOT for session two and 2.47 K/C per 1.27 HOT for session three. The limited time of the session (10 minutes) and the increase in time it takes the preservice teacher to use higher level HOT questioning practices limited how much this ration could change. The higher level HOT questions took longer to execute, when performed correctly, and left less time for the candidate to ask K/C questions. The comparison group generated mostly K/C questions and did not grow in their use of HOT questions. The ratio between K/C and HOT questions for session one is 3.33 K/C per .07 HOT, for session two 3.40 K/C per .13 HOT, and for session three 3.36 K/C per .07 HOT. Without the insight from a coach (or other kind of mentor) the comparison group members, with respect to HOT questions, did not have a specified opportunity to improve on their performance.

Relation of research question one to the literature. Observations of live instruction followed by feedback and coaching can help improve individual practices of an educator (Kraft & Blazar, 2013). Coaching improved the questioning skills of preservice teachers in the treatment group. Feedback from a mentor, expert, or coach is crucial in gauging where one currently stands, and how one might improve (Boody, 2008). The treatment group engaged with a coach, created a plan, and performed a lesson with clear goals in mind. Data-driven feedback and coaching can be used to influence improvement in one's practice. In the real-world education environment, administrators give feedback to teachers using data-driven rubrics to measure classroom interaction, personal observation, and/or a combination of both (Blazar & Kraft, 2015). For the preservice teacher, the complex decision-making world of the classroom can seem immensely frustrating when trying to focus on self-improvement. Having a good foundation provided by a coach can be a powerful tool to engage in improvement (Kraft & Blazar, 2013). The researcher can be seen as the one who facilitates meaning-making. Laverick (2016) explains meaning-making as a, "process that moves a learner from one experience into the next with deeper understanding of its relationships with and connections to other experiences and ideas" (p. 58). The treatment group was able to use the feedback and coaching to create a deeper understanding of questioning skills which resulted in better HOT questions in the first session, then in the last two simulation sessions they used HOT questions more effectively.

Suggestions for Future Research

The researcher used this study's design to explore the effect of data-driven feedback and coaching on preservice teachers' lesson design and delivery using a mixed-reality simulation. The skill that was focused on was the high-leverage practice of using higher-order questions in a lesson. A new study could be conducted in the same manner but with a different high-leverage

practice. This could provide the institution with feedback on the effectiveness of the coaching interventions in regard to training preservice teachers' use of high-leverage practices.

In this study the treatment group was able to have a ratio of 2 K/C to 1 HOT question when the participants where engaging in the higher levels of HOT questioning practices during a 10-minute lesson. A suggestion for future researcher would be to explore what the optimum ratio should be during a given time in the mixed-reality simulation. The could lead to understanding the best practices in setting goals and measuring performance for preservice teacher training in the simulator.

Research Question Three

Research Question

What are the perceptions of preservice teachers' abilities and experiences in using a mixed-reality simulation where one group receives data-driven feedback and coaching throughout a semester about their performance scores for the number and types of questions they ask while teaching lessons and the other does not?

Research Question Three Results

While analyzing the coaching sessions and final interviews four main themes emerged: (a) data-driven feedback and coaching improves self-efficacy, (b) planning for a lesson requires reflection, (c) lesson performance is enhanced by reflection, and (d) data-driven feedback and coaching improves questioning skills. The themes "planning for the lesson" and "lesson performance" connect to ideas of teacher growth through reflection. Reflection among teachers typically falls into one of four categories: reflection as retrospection, reflection as problem solving, critical reflection, or reflection-in-action (Boody, 2008). The categories "type of feedback and coaching effect" and "one's questioning skills" give insight into the participants'

skill growth and their perceptions. When teachers receive explicit training or coaching on a classroom skill they improve significantly more than those who have to grow that skill on their own (McKinnon, 2012).

Theme One: data-driven feedback and coaching improves self-efficacy. As noted in research question two, the treatment group performance for creating higher-order thinking questions was overwhelmingly better than that of the comparison group. Every member of the treatment group indicated they improved in HOT question creation and that those questions were implemented into the lesson across the three sessions. They were engaging in master of experience and with the data-driven feedback and coaching given from the researcher received useful encouragement for their skill growth (Bandura, 1994). The majority of the comparison group members felt their overall questioning skills were unchanged. Some even stated they felt unclear on what a true HOT question was, or where to use one in a lesson. To develop preservice teachers' skills, one must give opportunities to practice that skill and clear guidance to help them grow (Blackley et al., 2017). Members of the comparison group, without some type of guidance, were having issues with the basic concepts regarding HOT question creation and integration of these questions into a lesson. It is also important to note that these differences in self-efficacy statements where not present in the data for research question one. That instrument only addressed general teaching practice. However, when members of both groups are asked directly about their use of questioning skills, the comparison group lacked growth.

Theme Two: planning for a lesson requires reflection. The treatment group members credited the coaching sessions for helping them develop better planning skills. From the very first individual meetings, before the researcher had performance data to share with them, the treatment group members asked questions about how to create and use HOT questions in their

lesson. Once the researcher had performance data to report back to the participants, they were able to use these data as evidence to reflect on how to improve. This was interesting because their performance in the simulator was not rated or part of a course grade. The three mixed-reality simulations just needed to be a completed set of activities so they could move to student teaching. The researcher believes, because someone was keeping track of their performance and actively giving them dialogue to improve, they felt more inclined to give more time to planning. They said that they not only planned more, but planned better, due to the coaching intervention. This connects to reflection as retrospection and reflection as problem solving, described by Boody (2008). Reflection as retrospection requires reconsidering and learning from prior experiences and reflection as problem solving places an individual in a prior event to think about how a situation might have been handled differently. In this case, the coach helped to facilitate reflection as retrospection and reflection as problem solving when treatment group members changed their habits and increased lesson-planning time.

With the comparison group, planning was much more limited. Unlike the treatment group, the researcher only had contact with the comparison group at the end of study, during the telephone interview. In that interview, all comparison group members received data-driven feedback about their performance using questioning skills throughout the semester. Twelve out of 14 of the comparison group members explained they did not change their planning methods after the simulator sessions. This result, could mean that they either failed to engage in reflection, possibly because there was no specific coaching guidance (Boody, 2008) or they reflected, but did not have the skills to make appropriate changes. Two participants even admitted to planning the entire lesson right before their session began, on the same day. Unlike the treatment group, without someone giving them guidance and tracking their progress, the

comparison group members did not treat the simulation as seriously and did not engage in useful reflective practices for growing their skills. This last comment speaks to dispositions of future educators, a critical element in any teacher educator program (NCATE, 2015). The coach for the treatment group members was able to have them improve their questioning skills, despite the fact that there was no grade recognition for completing a lesson.

Theme Three: lesson performance enhanced by reflection. Referring to research question two, the treatment group performed much better than the comparison group in creating higher-order thinking questions. The perceptions of the treatment group in other aspects of the simulated lessons were also positive. All members of the treatment group responded that their lesson performance improved over the course of the semester and they were able to adapt to unplanned interactions in the lesson. This relates to critical reflection and reflection-in-action (Boody, 2008). Critical reflection focuses on the educator's actions within a measured system. Policies, rubrics, administrative goals, community members, and many other factors are part of critical reflection to aid in implementing improvements (Boody, 2008). In this research, the data-driven feedback provided was unitized by the coach to encourage the participants to critically reflect on their performance. The comparison group participants did not engage in critical reflection. Most members felt that their lesson performance was unchanged or even worse compared to previous semesters.

Reflection-in-action occurs during a current event or situation, during a time in which one may change the outcome in a meaningful way. Boody (2008) acknowledged "reflection-in-action may seem unconscious, actions going on under the surface" (p. 502). Giving a person experience in the desired task while training them to be a reflective practitioner provides them with more flexibility in dealing with issues in the moment (Boody, 2008). The treatment group

members entered the lesson well prepared with a clear plan for their lesson objectives and strategies for engaging student learning through the use of questions. Most of the treatment group members noted the simulated students responded well to their lesson with very minor issues in classroom management. These teacher candidates reported that they were also able to adapt in the moment. The comparison group members did not share the same experiences as those in the treatment group. Most members stated they felt they did not improve in their overall lesson performance over the semester. They also noted more instances of classroom management issues and problems adapting to unexpected student interactions. Without direction from a coach, or another type of intervention, their ability to engage in the practice of reflection-in-action was limited.

Theme Four: data-driven feedback and coaching improves questioning skills. The treatment group had high praise for the coaching provided by the researcher. Every member of the treatment group recognized his or her own growth in questioning, lesson planning, and lesson performance, and asked if the coaching could continue in future classes. They also felt the short feedback they received from the facilitator after they completed the simulation was helpful but did not believe it was as supportive or robust as the one-to-one coaching phone calls. Most of the comparison group members thought the short feedback they received after their session was helpful. However, a few stated they honestly did not remember what was said or did not even receive feedback because the session was running short on time. Referring to earlier data, members of the comparison group felt their overall questioning skills were unchanged. It is also worth noting that even though the comparison group members were separate from the treatment group, a few asked for a system to be added that resembled the coaching the treatment group received. This suggestion came from a few music majors who, in their instrument classes, have

one-on-one time with their professor. They felt that a mentor or coach position could be a positive addition for the mixed-reality simulation sessions.

Suggestions for Future Research

A topic that could be researched relates to how the mixed-reality simulations could be best integrated into the education courses for preservice teachers. Currently, in the university where this study was conducted, nine simulator sessions with targeted skills must be completed before a candidate can register for student teaching. Only a few professors have integrated these simulator sessions into their course sections; most have not. Studying the effectiveness of integrating the simulation sessions into courses would be relevant.

A videorecording system was created by the researcher for collecting data. However, many of the participants requested copies of the recordings of their sessions, so they could use them for self-improvement. Unfortunately, due to lack of advanced recording technology, we were not able to provide participants with their individual session videos. This could be an area for a future study. One could study the effects of having students reflect on their own mixed-reality teaching sessions. Participants could watch themselves and critique their own performance. This could be taken another step further by following preservice teachers throughout the teacher-preparatory program and mapping their growth through videos of their performance.

Program Recommendations

Data-driven coaching be included in the experience of using mixed-reality simulations in a preservice teacher-education program. The simulation should not be treated as an isolated experience. If the institution allows it, the sessions should include a coach for the duration of the semester. The coach can bring context to the events that happen within the simulator, while

giving the participant the topics needed for reflection and improvement. Additionally, the preservice teacher's performance growth can be tracked throughout the semesters that use simulations. This can give each preservice teacher insight into his or her own strengths and weaknesses before entering into the student teaching environment of a real classroom. This mirrors the best case one would hope to have as a beginning teacher. Beginning teachers should have a coach/mentor (department head, principal, etc.) who observes them in class, meets with them to discuss performance, creates an improvement plan, observes the class again, and revises the plan to maximize skill growth (Kraft & Blazar, 2013). This research's treatment reflects that model.

Limitations of the Study

In the quantitative aspect of this mixed methods model a quasi-experimental design using intact groups was employed. There are several limitations inherent in this design as well as in the nature of the particular research. While each student was not randomly assigned to either a treatment or comparison group, the course sections studied were randomly assigned to either condition. The treatment was conducted in a timely way; therefore, the researcher gave the feedback to the candidates in the treatment group within two to four days after each session. Lastly, subjects in the study had to adhere to the guideline of the study in allowing their sessions to be videotaped.

Quantitative Limitations

Internal validity. All studies have potential threats to the design. Major threats to the quantitative aspect of the study are described below as are potential procedures used to ameliorate most issues.

Maturation occurs when a study is conducted over a long period of time and the participants change in skill levels or behaviors due to the passage of time (Gall et al., 2006). For this research there was minimal threat of maturation. This was due to the brief length of time for the study (one semester).

Differential selection is a concern when participants are not randomly selected and randomly assigned to a group in a research study. Any other type of group assignment can affect results due to participants' previous skills or knowledge, rather than having results due to the effects of the treatment (Gall et al., 2006). To partially address this threat, the course sections were randomly assigned to either a treatment and comparison group. It was also known that the students were approximately at the same level in their coursework in the education certificate program. Their GPA values were compared to find out how equivalent the groups were. An independent sample *t*-test was conducted in SPSS to examine the significance between the treatment group and the comparison group members in regard to their GPAs (Meyers, Gamst, & Guarino, 2006). In reviewing the results there was no significance difference, $t(27) = -1.77$, $p = .09$, in the GPAs for the treatment group ($M = 3.48$, $SD = .23$) and comparison group ($M = 3.64$, $SD = .25$).

Experimental Mortality happens when participants for some reason cannot complete the study or leave information unanswered, creating missing data for the researcher (Gall et al., 2006). There was a moderate threat of experimental mortality within the study. The participants being studied were video recorded during each session. If someone missed a session or a session was cancelled due to inclement weather there were make-up sessions days. Despite the added make-up days, two students in the treatment group were eliminated from the study due to not being about to attend all the simulation sessions.

Compensatory Rivalry by the Comparison Group refers to the situation where participants from the comparison group change their behavior to match or exceed the treatment group (Gall et al., 2006). There was little to no known threat of compensatory rivalry by the comparison group for this study since students were in either online (comparison group) or hybrid (treatment group) course sections, with little opportunity to communicate during the course. There were no instances where a group member gave an indication of the activities transpiring with members of the other course section.

Hawthorne effect refers to the fact that participants in the study are aware they are being observed and behave differently (Gall et al., 2006). The threat within the study was low. Subjects knew that they were in a study, however they had experienced the mixed-reality simulation in former courses and were not unduly impacted by being observed.

Novelty and disruption effects occur when participants experience something new when they do not usually experience changes, thus creating excitement or distraction (Gall et al., 2006). There was a low threat of novelty and disruption effects anticipated for this study. Although the mixed-reality simulation system was relatively new, the students in this study had already used it many times in previous semesters.

Experimenter effect refers to the researcher unknowingly affecting the attitudes or performance of participants through interactions (Gall et al., 2006). The threat of experimenter effect was low since the same researcher collected all data and had developed a contact protocol when providing feedback and coaching. In addition, the mixed-reality simulation was not incorporated into the course, making the effect of the professor quite minimal.

Pretest sensitization occurs when initial data collection impacts the results of the study. If the same research is conducted again without the pretest or the initial data collection process

one would get different results (Gall et al., 2006). Regarding the observations, the simulator had been used in other classes in the program and the participants were used to being observed. The data from the TSES were collected at the beginning and end of a 15-week semester. Making the time difference between pre and post reasonable for this survey to be effective in regard to length of time between testing periods.

Posttest sensitization happens when the act of giving the posttest could affect the results. If the same research is conducted again without the posttest one would get different results (Gall et al., 2006). There was a low threat of posttest sensitization anticipated for this study since the students were familiar with the format of being observed during their simulation sessions.

External validity. While generalizability of the results can only be applied to this particular sample, the design could be replicated if care is taken to implement the study in another location as it is described in the final report of findings.

Trustworthiness Related to Qualitative Procedures

Credibility ensures that the study measures or tests what is actually intended, precautions were taken by the researcher to ensure findings reflected reality (Creswell, 2013). The researcher has kept accurate notes of all observations, was trained in using the data collection methodology, and periodically compared observed data with that of others trained in scripting lesson activities and coding responses. Audio- or videorecording devices were used in all interviews. An external audit was conducted and there was 100% agreement between the auditor and the researcher (see Appendix G).

Transferability is making sure the methodology should be applicable to other situations through the researcher's thorough description. Other researchers should be able to understand how the results of the study apply to another setting (Lincoln & Guba, 2006). The researcher

feels he has provided enough descriptive data through the coding of the coaching sessions and final interviews, while answering the third research question, that another researcher can use these findings for comparison in a similar study.

Dependability is achieved if the work is repeated in a similar context, with the same methods and with similar participants, then one would expect comparable results (Lincoln & Guba, 2006). The researcher displayed due diligence in being completely honest in describing all procedures and has made all materials, such as interview questions and coding techniques, available in this documentation.

Confirmability is acquired when the researcher takes the necessary precautions to ensure that the study's findings reflect the views and thoughts of the participants and not that of the researcher (Creswell, 2013). The researcher compared his data with that of an expert to calibrated his coding methods. Also, while engaging in the coaching sessions with the members of the treatment group, the researcher reported the performance to the participants and each participant, in each session, agreed that the information was correct. Lastly, all interactions with participants (audio and video) were recoded and made accessible to the leadership at the researcher's university, to maintain full transparency in all aspects of the study.

Limitations for Future Researchers Using Mixed-Reality Simulations

To conduct this study the researcher had to create a custom videorecording system to capture each participant's performance using the mixed-reality stimulator. There were three reasons for the need of this system. The first was to validate each performance since there could have been a chance that the researcher could not attend a session to record the data in person. The second reason was to have an archive of the participants' performances, so the researcher could review the session multiple times to code the questioning data. Lastly, the researcher

wanted to gauge his coding against an expert. Because the expert could not attend these sessions the videos needed to be made easily accessible for her. It is also important to note these video files should be treated with care and stored in a manner that protects them from theft. The researcher used an encrypted files storage system both online and offline.

The study was conducted at a state university where approximately half of the students are commuters, who have full time jobs while they attend school. Because the treatment was voluntary, the researcher had to make it as accommodating as possible for the participants to access the data-driven feedback and coaching sessions. The researcher had to call the participants (telephone or Internet voice chat service) on their free time, as they had designated. This meant the researcher had to be very flexible with his time, because each participant's schedule was unique. However, even then it was difficult to keep in contact with the participants because of shifting calendars and unforeseen circumstances (snow days, illnesses, etc.). The researcher also had to have the data and talking points ready before each call because each coaching session had to be both individualized and a brief as possible to accommodate the participant.

Statement of Ethics

The researcher had received prior approval from the university's Institutional Review Board (IRB) before beginning research. To validate the trustworthiness and creditability of this study specific guidelines were followed. The subjects at no time during this study were current or former students of the researcher. Consent was obtained from the Chair of the university's Department of Education in order to access student video recordings, professor of the course sections, and each preservice teacher. All consent forms are located in Appendices G,

respectively. Each form indicates that all participation is voluntary. All candidates' personal information was kept coded and confidential.

Conclusion

This researcher's goal was to give insight into how teacher-preparatory programs can enact the best training practices when using mixed-reality simulations. If the goal of the mixed-reality simulation is to simulate the experience of teaching a classroom then we must also simulate the entire teacher experience, which includes some type of coach, professor, or mentor to guide their skill growth. Stated earlier in the researcher's recommendation, the best case for a beginning teacher would be to have a coach or mentor (department head, principal, etc.) who observes them in class, meets with them to discuss performance, creates an improvement plan, observes the class again, and continues on for further skill growth. Jamil et al. (2012) suggested, "preservice teachers need opportunities to receive accurate, yet constructive feedback about their teaching performance during field placements in order to make well-balanced judgments about effective and less effective teaching moments" (p. 133). In its current state, the mixed-reality simulator can only push the preservice teacher to limited heights in skill development. The inclusion of a coaching model seen in this study could help in building preservice teachers' advanced skills such as using higher-order-thinking questions before they enter a real, live classroom.

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Appendix A: Educational Psychology II Course Syllabus and Lesson Expectations

Educational Psychology II Course Syllabus

State University
Education and Educational Psychology Department

NEW Course:	Approved May 2014/Approved Gen. Ed. Nov. 2015
Course Number:	ED 212 and EPY 204
Course Title:	Educational Psychology II: Childhood and Adolescence
Semester Hour Credit:	3 SH

Rationale:
This course is designed to assist the aspiring elementary level teacher in meeting the requirements necessary for Connecticut State Department of Education teaching certification. Students will learn about prominent theories and practices in adolescent development and educational psychology. They will also participate in dialogue and activities to create their own meaning of the teaching/learning process while engaging in the constructivist approach. An ongoing emphasis will be on connecting theory with practice based on learner experiences and clinical experience.

Course Description:
This is the second course in a two-part session in Educational Psychology. Major theories and research about adolescent educational psychology in school settings are emphasized. Other topics include the effects of heredity and environment; cognitive and socialization processes; measurement and assessment of intelligence; learning styles; conflict resolution; exceptionalities; and family, peer, school and media influences on growth in a culturally diverse society. Field work experience for this course will be done to combine theory with educational practices (20 hours).

Learner Outcomes:
As a result of participating in this course, the candidate will…

1. discuss the impact that cultural, linguistic and environmental issues such as economic status, and social class, have on the learning needs of students apply theories of behavior in to the educational setting by effectively managing a classroom
2. analyze and assess current issues and trends in adolescent growth and development
3. apply theories of complex cognitive processes to situations in the educational setting
4. synthesize diverse theoretical perspectives of educational psychology on children and adolescents into a clear, defensible perspective of their own
5. evaluate his/her own developmental experiences in light of course content
6. apply a working knowledge of theory and research on educational psychology to educational settings
7. apply his or her knowledge of developmental and cognitive differences in students through instructional differentiation and assessment

Information Literacy (IL) Competency Outcomes:
Upon completion of the Information Literacy Competency, students will be able to:
1. *Access, navigate, identify, and evaluate information that is appropriate for their*

need(s) and audience(s): Candidates in this course will use technology to explore the impact that cultural, linguistic and environmental issues have on the learning needs of students.

2. *Understand the ethical dimensions of the use of information:* Candidates in this course will discuss the ethical dimensions of the use of information in their discussion of student case studies.

3. *Synthesize information to broaden knowledge and experiences and produce both independent and collaborative work:* Candidates in this course will work individually and in groups to synthesize the diverse theoretical perspectives of educational psychology into a clear, defensible position.

4. *Apply current, relevant technologies to solve problems, complete projects, and make informed decisions*; Candidates in this course will apply knowledge of developmental and cognitive differences in students through differentiation and assessment to make instructional recommendations.

5. *Understand the economic, legal, or social issues surrounding the ownership, access and use of information and relevant technologies:* Candidates in this course will explore the economic, legal, and social issues surrounding the ownership, access, and use of information and relevant technologies in their case study assignments.

Appendix B: Mixed-Reality Simulation Scenario

EPY 204/ED 212 TeachLivE Scenario

Simulation Classroom: Middle School Classroom
Level: Initial, Preservice
Certification Level: All
Content Area: All
High-leverage practice #8 (HLP): *Higher-order Thinking Skills*
Number of Simulations: 3 per semester
Lesson Planning: Follow professor guidelines

Background: You are a recent college graduate teaching a group of middle school students. Your school district is focusing on HOTS (higher-order thinking skills) as a focus for district goals. Use Bloom's Taxonomy to ask your students questions using the three highest levels (analyzing, evaluating, creating) to teach a lesson in your content area. Please prepare a lesson plan prior to each of the three simulation lessons following your professor's guidelines. See below for the specifics of all three simulations this semester.

Simulation #1: **Task:** Introduce the content with varying levels of questioning.
Pedagogy: Teacher directed and/or individual, small group or whole class discussion

Performance Objectives for Simulation 1:

Challenge 1		
	When teachers…	**Avatars will…**
Hit	The teachers will introduce a lesson on a content of their choice. Students will begin to focus asking questions on the highest levels of Bloom's Taxonomy (analyzing, evaluating, creating) in their introductory lesson.	Provide mild or compliant behaviors to the instruction.
Miss	The teachers are unable to introduce varying higher levels of Bloom's Taxonomy in questioning.	Moderate noncompliance behaviors for lesson 1.

Simulation #2: **Task:** Lead a discussion using varying levels of questions (highest Bloom's taxonomy levels).
Pedagogy: Think/Pair/Share, One-on-one coaching to elicit student thinking; whole group discussion.

Performance Objectives for Simulation 2:

Challenge #1		
	When teachers…	**Avatars will…**
Hit	Teachers will successfully lead a think, pair, and share activity to ask varying higher levels of questions at Bloom's Taxonomy's highest three levels.	Compliant behaviors mixed with several mild non-compliant behaviors.
Miss	Teachers do not successfully ask varying levels of questions at Bloom's Taxonomy's highest three levels.	Moderate non-compliant behaviors.

Simulation #3

Task: Develop a formative assessment to check for understanding and conclude lesson. Use higher-order thinking questions.
Pedagogy: Whole class discussion using student feedback, checking for understanding and monitoring learning.

Performance Objectives for Simulation 3:

Challenge #1		
	When teachers…	**Avatars will…**
Hit	Teachers will successfully lead a whole group discussion to elicit feedback from the avatar students by using higher-order thinking questions.	Compliant behaviors mixed with several mild to moderate non-compliant behaviors.
Miss	Teachers do not successfully ask higher-order thinking skills questions.	Moderate non-compliant behaviors.

MATERIALS

Teacher will use content within their certification areas. However, no pre-knowledge will be required of the avatars. Students will use content common to the middle school level.

REFLECTION PROMPTS

What one thing did you do well? What one thing would you do differently? Why and how? How has your host teacher used graphic organizers? What connections did you make between the simulation and your clinical practice?

Appendix C: Ending Participant Interview

Ending Participant Interview

Interview questions at the end of the study

1. How do you think your teaching has changed during this past semester?
2. What did you do to prepare for each TeachLivE lesson? Where did get your ideas from?
3. What could have helped you to be better prepared?
4. What was your planning strategy to develop a lesson that would engage students in higher-order thinking? Do you think you asked appropriate questions to engage students in higher-order thinking? (look at lesson notes)
5. Did anything about the students' responses change the way you taught your lesson? Did you teach your entire lesson every time? What changed the way you taught?
6. What are your thoughts on the coaching (feedback) given after each TeachLivE session?
7. Did the coaching effect your TeachLivE lesson? If so how?
8. Are you satisfied with your performance TeachLivE sessions this semester? What do you think about TeachLivE as a teacher training tool?
9. What feedback or resources would have been helpful? What advice would you give to a student just beginning this course?
10. How can we improve this experience in the future?

Appendix D: Data-driven Feedback and Coaching Protocol

Semi-structured Data-driven Feedback and Coaching Protocol

Contact will be made with participants in the treatment group through phone calls or Internet conferencing systems such as Skype or FaceTime. It is planned that each session should not exceed 30 minutes.

1. Refer to the demographic form, I see that you are in the elementary education program/secondary education program. What topics do you look forward to teaching when you complete the program?
2. How do you think the TeachLivE experience is preparing you for student teaching?
3. In your most recent TeachLivE session, how do you think you did?
4. How do you think you did with respect to the questions you asked?
5. What seemed easy to do? What seemed difficult?
6. Report their CPR results: At this time the researcher will explain the number of K/C and HOT level questions the participant generated during the lesson.
7. After the results are given the researcher will take this time to answer any questions to make sure the participant understands the results.
8. What do you think about these results? How were you thinking about the types of questions you were asking during the session?
9. What do you think you could do to improve your questioning skills? What do you think you could do to prepare to include more HOTs questions in your next session?
10. Do you need any additional resources to help you achieve your goal?
11. Recommendations for next session: At this time the researcher will give some strategies with their questing skills.
12. Finally, the call will end with closing rapport.

Appendix E: Participant K/C and Leveled HOT Questions

Session One Treatment (T) and Comparison (C) Participant Questions

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T01	Food Chain	Did your lunch have meat? Asked class Where did the turkey get its food? Asked Ed Where do plants get their food from? Asked CJ What is the energy source from the sky? Asked CJ	What events can make a food chain out of order? Paired in to groups-little wait time LEVEL 2	C01	Note values	What is a note value? Asked class How long to you hold a ¼ note? Asked Shawn What is the opposite of holding a note? Asked class What is the difference between the two scales I sang (sang two scales)? Asked class Why is the dot there in the notes (line long, dot short)? Asked class-students ask questions to clarify	
T02	Eco Systems	What is an eco-system? Asked class What are the living parts of the eco-system? Asked class	Pick one of 3 places, fish tank, city, forest, are these an eco-system? Asked class-but into groups LEVEL 2	C02	Songs in key	What song is this (plays song on iPhone)? Asked class What is different with this song (plays song on iPhone)? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What are the non-living parts of the system? Asked class	Why is it important know about eco-systems? Asked class- put into groups LEVEL 2			What is the difference between major and minor key? Asked class What step is lower? Asked class What other notes are flat? Asked Shawn What is the change in the symbols (points to sheet music)? Asked CJ What kinds of music uses this, it's emotion? Asked class	
T03	Food chain	What is the tropic level? Asked Ed Why are animals on the 2nd level larger? Asked class Where are humans in this? Asked class	Can you be at the top and be a vegetarian? Asked class-little wait time LEVEL 1 What would happen if sharks became extinct? Asked class-little wait time LEVEL 1	C03	Instruments in an Orchestra	What are the instruments in an orchestra? Asked Class What are the families of instruments? Asked Class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T04	Mental Health	Kevin, what is an example of an emotion? Asked to CJ Asked to Ed Can anger always be negative? Asked to Kevin	How do you tell if an emotion is positive or negative? LEVEL 1 Little wait time How do our emotions effect how we make choices? Work in groups LEVEL 2 Each group shared responds	C04	Basic Music Theory	Why do these notes have these names? Asked Class	
T05	Parts of a story	Who likes stories? Asked class What are the parts of a story? Asked class What kind of story starts fast? Asked class What's the most action part of a story? Asked class	If the climax was missing from a story can it still be good? Asked class- little wait time What makes a story good? Asked class-little wait time then went to Maria If there's no resolution is a story still good? Asked class-little wait time	C05	Story		
T06	Spanish	Who can say, "hi," in Spanish? Asked Class	What are the benefits of learning a new language?	C06	Types of Music	Example of popular music? Asked class Example of classical music?	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Who can say, "goodbye," in Spanish? Asked Class	Asked Class- Gave good wait time for them to write answers went to each student, LEVEL 2			Asked class What are the instruments in a classical music band? Asked Ed, then others.	
T07	Environmental issues	What tech do we always use? Asked CJ Can anyone think of anything else (tech)? Asked class How are basketballs made? Asked Ed	Are the advances in society worth the environmental cost? Asked class-gave short wait time to write down answer, LEVEL 2	C07	Sound dynamics	What was different about what I said (she sang greetings to the kids)? Asked class What are some loud or soft sounds in life? Asked class What are they called (holds up paper with music symbols on them)? Asked class-does both symbols What did I do in the song (sound a song in loud and soft points)? Asked class-class to make their own loud or soft simple songs.	
T08	Human body systems	How many systems are in the human body? Asked Class		C08	Physical activity	What is healthier Oreos or apples? Asked class-asked for them to explain reasoning	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What is the function of the skeletal system? Asked class How many bones are in the human body? Asked class Why do babies have 270 bones? Asked class What are the bones in your arm called? Asked				What is heather chips or broccoli? Asked class-asked for them to explain reasoning	
T09	Order of operations	Can anyone tell me about orders of operations? Asked Kevin What is the order in the operation? Asked each student each part		C09	States of Matter	What are the states of matter? Asked class What is matter? Asked class What is matter made of? Asked class What are the forms of water? Asked class	
T10	Food Groups	What are the 5 main food groups?	Are we what we eat? Asked class- has class write down ideas and	C10	Intro to Music	Is a quiet classroom music? Asked class	What do you think Music is?

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Asked class-had class list them What food group does pizza fall into? Asked CJ	then had class report on them LEVEL 2 If you only ate one color of food for a month what you be the best food to eat? Asked class- no wait time LEVEL 1				Asked class- Gave time and write down response LEVEL 2
T11	Maps	How do we get from place to place? Asked class How does GPS work? Asked class What did we use before GPS? Asked class What features are on the Map? Asked class		C11	Types of octaves	What did I do (sang at different pitches)? Asked class What is the difference (sang two different times)? Asked class What is a major tirade? Asked class What is the differences in pitches? Asked class	
T12	Geography	How many continents are there? Asked class How many continents where there 250,000,000 years ago? Asked class	How would life be like if the world was still like Pangea? Asked class- no wait time LEVEL 1 Why is it important to learn about Pangea?	C12	Musical genre	What is a musical genre? Asked class What is an example of a musical genre? Asked class What is your favorite genre?	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Why did the continents break up? Asked class	Asked class- no wait time LEVEL 1			Asked class Why do you like singer song writers? Asked Maria Why do you like the genre you like? Asked class	
T13	Food energy	What did you eat for breakfast? Asked class Why is having a breakfast important? Asked class		C13	How to Read Music	What language is music written in? Asked Kevin What is the word for soft? Asked Ed What is the opposite of soft? Asked class What is tempo? Asked Maria	
T14	Exercise	Who exercises? Asked class How do you exercise? Asked Ed What kinds of exercises are there? Asked class- had students list them	Do you think an 81-year-old person can still exercise? Asked class-no wait time LEVEL 1	C14	Rhythm	How many tones in this sound do you hear (clapped)? Asked class What note is this (holds up paper with note on it)? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What activity needs a lot of balance? Asked Kevin				What does this make (holds paper notes together)? Asked class	
T15	Types of History	What are different kinds of history? Asked class-went to most students Similarities between family trees? Asked CJ What is your favorite music? Asked Kevin		C15	Favorite Music	What's your favorite song? Asked class	

Session Two Treatment (T) and Comparison (C) Participant Questions

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T01	Food Chain		What if the sun didn't exist in the food chain? Asked class-has them pair up to think of answer LEVEL 2	C01	Dynamics	What does a loud dynamic sound make you feel? A soft dynamic sound? Asked class to write answers Relate these feeling to a genre? Asked class What is precipitation? Asked class How do you use piano or forte in an explanation? Asked Shawn	
T02	Eco systems	What are the parts of an eco-system? Asked class What is a non-living component? Asked class What is precipitation? Asked class	How does the amount of precipitation effect what lives there? Asked class-little wait time LEVEL 1 How does precipitation effect a desert and a forest (make a list)? Asked class-make students make a list LEVEL 2	C02	Creating music	What key is this in? (holds up larger sheet music) Asked class What chord is do? Asked Maria What notes are in a one chord? Asked CJ	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
						Does "sol" fit in the next chord? Asked Ed then goes to each student What chord would sound best for this? Asked class	
T03	Food chain	What level is the top of the food chain? Asked class	What would the world (food chain) be like without humans? Asked class-put into groups-went into each group got long answers from each group LEVEL 3	C03	Families of symphony orchestra	Name one instrument family and one instrument in that family? Asked CJ, then class Why do they need to be in different families (elements of sound)? Asked class What kind of instrument would have a bright (tambour) or dark sound? Asked class	
T04	Mental health		Gave issue about depression. How do you help your friend who is depressed? Asked class-put into groups, LEVEL 2 Come up with choices that would have a	C04	Note length	What kind of notes are there? Asked Shawn Why are the notes called what they are? Asked class Why is called a ¼ note?	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
			positive outcome and negative outcome? Asked class-put into groups, LEVEL 3 high level response from Kevin and ran out of time			Asked class Why split up the notes? Asked class	
T05	Persuasive essay		Can you write a persuasive essay and not believe what you are writing about? Asked class-put into groups LEVEL 2 Can you write about something you disagree with and take its side? Asked class-not wait time LEVEL 1	C05	forms of matter	What is physical change? Asked class Give me examples of physical changes? Asked class	
T06	Spanish	How would you ask for someone's name? Asked class How do you say nice to meet you? Asked class	What is Spanish? (what is Spanish culture) Asked class-put into groups LEVEL 2	C06	How we make music	What kind of music you listen to? Asked Kevin, then class What kinds of effect does your favorite song have on you? Asked Ed, then class	Imagine a world without music? Asked Kevin-then class-no wait time LEVEL 1
T07	Environment vs industrialization	What is Industry? Asked class	How can we make the environment better while still having industry?	C07	Music animal tempo	What speed are the animals (shows pictures of animals)? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What are some of the pros and cons to industry? Asked class	Asked class-no wait time LEVEL 1			What is tempo (names on the back of the animal pictures)? Asked class What is the word for fast to slow" Asked class Let's go through the names and connect them to speeds? Asked class What tempo is this song (plays the same song at different speeds on a guitar) Asked class	
T08	Body systems	How many systems are in the body? Asked class What is the bone that cover the brain? Asked class	What would it be like without having the nervous system? Asked class-has students write answer LEVEL 2	C08	Health	List all the parts of health (like sleep etc.)? Asked class What is occupational health? Asked CJ	What is health/what makes a person healthy? Asked class- No wait time LEVEL 1
T09	Order of operation	What is order of operation? Asked class Why do we have to do the equation in an order?		C09	Scientific method	What are the steps to the scientific method? Asked class What is a hypotheses and next steps? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Asked class Why does the number become its reciprocal when it comes to the other side? Asked class				 What do we do when we run an experiment and after? Asked class What do you need to have an experiment? Asked class	
T10	Eating heathy		What if you can only eat on color of food? (Asked question from first session) Asked class-not wait time LEVEL 1 Why is eating heathy so important for society? Asked class- no wait time LEVEL 1 How can you as a person help your family eat better? Asked class-put into groups LEVEL 2	C10	Tempo	What is Tempo? Asked class Asked what is largo? Asked class What is a thing that's slow? Asked class What is the word for very fast (what is something fast)? Asked class	
T11	country's culture and resources	Why does CT have seafood? Asked CJ	What contributes to a country's culture and resources?	C11	Instruments	Name an Instrument? Asked class (teacher made a list on big paper so class can see)	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What is the difference between CT and NE? Asked Class	Asked class-had them write down answers LEVEL 2 How does climate effect a country's culture? Asked class-no wait time LEVEL 1			How are these Instruments connected (what categories are they in)? Asked class How do brass instruments sound? Asked class	
T12	Elements of a short story	What are the elements of a short story? Asked class What is the high point of a story? Asked class What is after the climax? Asked CJ "Don't judge a book by its cover" is an example of what? Asked class		C12	Piano vs forte	What is the difference between Piano and forte? Asked class Asked about the dynamics in the song she sang? Asked class Did you notice my loudness and changes (sang the song to the class)? Asked Shawn then class What do we use crescendo for? Asked class	
T13	Food and energy	Why does your body need energy? Asked class What is the most important meal of the day?		C13	Music Terms	What's the term for loud (then again for soft)? Asked class What's the word for really soft? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Asked Kevin What is heathier than lucky charms? Asked Shawn What did you have breakfast (break down of your food)? Asked Ed What is a healthy breakfast and what isn't? Asked class				What is the difference between panino and pianissimo (then again for louder)? Asked class	
T14	Diet and movemen t	How much exercise should we get a day? Asked CJ	What is better exercise or eating healthily and why? Asked class- had them write down answer LEVEL 2	C14	Song Pacing	Hear what is the difference (sang same song twice)? Asked class What's the word we use when sounds are connected? Asked class What are some other words to describe this? Asked class	
T15	Family history	Where were your family members born (write down and compare to person next to you)?	Why are we thinking about where our family is from? Asked class- not wait time LEVEL 1	C15	Notes that instrum ents play	Write down instruments that play low notes and high notes? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Asked class Have family members that moved to here (outside of the USA)? Asked class				What do you feel when you sing high notes? Asked class Is it easier to pluck the low strings or high strings? Asked Kevin	

Session Three Treatment (T) and Comparison (C) Participant Questions

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T01	Food Chain	What is the outcome in your food chain? Asked CJ	Make your own food chain? Asked class-write down LEVEL2 Could you change the ending of food chain? Asked class-no wait time LEVEL 1 Do you agree with Ed's food chain? Why? Asked Kevin-no wait time Level 1	C01	Parts of singing	How are expressions used in singing? Asked class What are 3 characteristics of being a good singer (write them down)? Asked class Is posture important? Asked CJ	
T02	Eco Systems	What are the factors in a desert and a forest of an ecosystem? Asked class What are some factors for living parts of an ecosystem (forest)? Asked Maria	Why are the planet and animals all over the world different? Asked class-no wait time LEVEL1	C02	Songs (parts of singing)	What Key are we in (holds up sheet music)? Asked Maria What is this major or minor (holds up sheet music)? Asked Kevin Do we see an accidentals (holds up sheet music)? Asked Kevin	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What are the factors for nonliving parts of an eco-system? Asked class				What are up or down in step (holds up sheet music)? Asked Kevin What kind of note is the 3rd note (holds up sheet music)? Asked Shawn	
T03	Food chain	What is the first tropic level (top animal)? Asked CJ What tropic level is your animal in? Asked class	What animal bothers you the most, and why? Asked class-put into groups LEVEL 2	C03	Instruments of symphony orchestra	What are some of the families? Asked class What are some tones a family can make? Asked class Pick an instrument and write down its family and type of sound it makes? Asked class What kind of tone and images are connected to a bass drum? Asked Kevin	
T04	Social health	Tell me 3 things about yourself (socially, had to write down and show partner)?	Why is it important to understand other people's social abilities?	C04	Pantomiming	Which part of pantomiming do emotions fall into? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		Asked Class	Asked Kevin- no wait time LEVEL 1 (lost a lot of time talking to Kevin)			Which part moves the plot forward? Asked class In pantomiming is the actor acting, or preforming? Asked class	
T05	Essay Bias	What topic can you easily defend in a persuasive essay? Asked class	How would you get past your own bias when writing a persuasive essay? Asked class-asked to write down LEVEL 2	C05	Chemical changes	Is crumpling up paper a physical change? Asked class What is a chemical change? Asked class If you light it on fire what does it turn into (is that a chemical change)? Asked class Is mold on bread a chemical change? Asked Kevin	
T06			What is Spanish (the culture)? Asked Class-work in groups-had long form back and forth with most students on many culture subjects. LEVEL 3	C06	Music vocabulary	What is the unity of place? Asked class What is the unity of action? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T07	Paper and environment	What are benefits of paper? Asked class What are the drawbacks of paper? Asked class	What would our world look like without paper in it? Asked class-had them write down LEVEL 2	C07	Beats in music	What is March Madness? Asked class What relates to the dribble to rhythm (teacher dribbling real ball)? Asked class How can we match the beat with the ball (sync)? Asked class What's the difference in the beat (dribbled a different way)? Asked class	
T08	The digestive system	What does the digestive system do? Ask Ed What are some of the parts of the digestive system? Asked CJ How does chewing help our food move down to the stomach? Asked class	What is the most important part of your digestive system? Asked class- no wait time LEVEL 1	C08	Health	What are the dimensions of health? Asked class	Which dimensions of health are the most important? Asked class-has them write down LEVEL2

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T09	Estimating	What is estimating? Ask class What is underestimating (overestimating)? Asked Kevin then CJ Give me some examples of underestimating and overestimating? Asked class	When is underestimating and/or overestimating bad or good? Asked class-no wait time LEVEL 1	C09	No data		
T10	Healthy eating	Would you rather make your own burger? Asked Kevin Is meat on the pizza, what is the best meat to put on? Asked CJ Is it cheaper to eat out? Asked Maria	If you were to make a burger at home rather than fast food is it heathier? Asked CJ then class-no wait time LEVEL 1 Why is healthy food more money (is it)? Asked class-LEVEL 1	C10	Tempo	What is tempo? Asked Class What is Largo, use an animal (sang a song)? Asked Ed What is Presto? Asked Kevin What is a thing that is presto? Asked CJ Why is keeping tempo important? Asked class	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
T11	Maps and climate	What is fall? Asked Shawn Do all countries have all seasons? Asked class Can you think of a place that has different seasons than us? Asked CJ What is weather? Asked class	What is so great about where we live? Asked class-no wait time LEVEL 1 If the weather so good in southern CA how come everyone doesn't live there? Asked class-no wait time LEVEL 1	C11	Music history terms	Why was the Baroque period also the Gilded Age? Asked class What does word painting meaning (write on paper)? Asked class How can we use word painting to describe something in music? Asked Ed/Kevin	
T12	Fable story	What was the conflict of the story (told a short story)? Asked Shawn Who was the antagonist and the protagonist in the story? Asked ED What is the setting? Asked CJ	Why do you think the sun won over the wind? Asked Maria, then class-wrote down LEVEL 2	C12	Rhythm	What is the difference in rhythm (sings song twice at different speeds)? Asked class What music mark is this? Asked class What kind of beats can be used for this (points to sheet music)? Asked Maria	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
		What are the characteristics of the characters? Asked Kevin					
T13	Health-basic needs	What are the basic needs to live? Asked Class What happens when you have no sleep? Asked class What about naps, are they healthy? Asked class	What happens to your body if you can't sleep for a long period of time (wanted long term effect)? Asked class-no wait time LEVEL 1	C13		What are Dynamics? Asked Class Think of a dynamic, what is it like? What is it's opposite? What is a movie that comes to mind with that dynamic? (all had to write this down) Asked class	
T14	Healthy eating	What was the last meal you ate (was healthy not healthy)? Asked class What does sugar do for your body? Asked CJ, then class	What is more beneficial to your health diet vs working-out? Asked class-had them write down LEVEL 2	C14	WW2 music	What major event happened from 1939-1945? Asked class What did you picture in your head when you hear these (played song from phone)? Asked class What words come to mind when you hear the song (after teacher translates it)? Asked CJ	
T15	History of	Who is Thomas Edison?	Why do we know about old inventors, but we do	C15	Dynamics	What are musical dynamics (work in groups)?	

	Subject	K/C Questions	Leveled HOT Questions		Subject	K/C Questions	Leveled HOT Questions
	Invertors	Asked class Who is Alexander Gram Bell? Asked class Who are the Wright Brothers? Who invented the cellphone? Asked class Who invented the computer? Asked Shawn	not know about new inventors, why is that? Asked class, had them write down, has long form back and forth between students- LEVEL 3			Asked class What is the difference between forte and piano (asked also mezzo version)? Asked class	

Appendix F: Full Researcher Coaching Session Codes

Full Researcher Coaching Session Codes

Code	Session 1	Session 2	Session 3
Appreciates One-on-One Coaching	0	15	15
Believes the Simulation is a Positive Experience	6	8	3
Connects Questioning to Good Teaching Practices	5	17	19
Displays Low Confidence in Performing the Lesson	3	1	1
Acknowledges that the Coaching had a Positive Effect on Lesson Implementation	0	23	21
Expresses Confidence in "Doing a Lesson"	0	10	11
Develops Clearer Questioning Goals after Coaching Session	2	9	15
Believes Session Went Well	0	17	7
Researcher: Explained Meanings of KC and HOT Questions	14	5	5
Researcher: Explained how data was collected	11	5	0
Researcher: Gave Coaching on Basic Lesson Structure	12	28	25
Researcher: Gave Coaching on How to Create HOT Questions	18	16	17
Researcher: Gave Coaching on Questioning Connecting to Leaners	3	14	12
Researcher: Gave Coaching on Questioning Practices	14	24	24
Researcher: Gave Performance Data	0	17	19

Appendix G: Qualitative Audit Document

Qualitative Audit for Mr. Wes DeSantis

An audit for Mr. Wes DeSantis' qualitative portion of his mixed-methods research study was concluded on March 12, 2018, by Kara Kunst Tanner, Ed. D. Mr. DeSantis met with Dr. Tanner to provide and overview of his research study, including the literature review, the qualitative case study, the research question, data collection, analysis, conclusions, and acquisition of participants. This involved a particularly detailed explanation of his coding process, code groups, and the summative content analysis of the data collected. A review of random parts of the qualitative data from the researcher including field notes, audio files, transcripts, and HyperResearch data files were examined. All coding appeared to be with 100% agreement between the researcher and the auditor.

Mr. DeSantis organized his data and conducted his coding using HyperResearch. He explained his coding process, including the summative content analysis using keywords and phrases from each interview. This led to the emergence of inductive codes, which were then grouped to unveil the underlying themes. After a review of the data, the coding process, the development of the inductive codes, and emerging themes led the auditor to the same conclusions. That data acquired from the interviews allowed for the research question to be answered fully. The recommendations and conclusion of this study were discussed, and this audit was completed successfully.

[redacted]

Kara Kunst Tanner, Ed. D. 3/12/18

Auditor Date

[redacted]

Wes DeSantis 3/12/18

Researcher Date

Appendix H: Consent Forms for Student Videos, Professor of the Course Sections, and Preservice Teachers

Consent to Obtain Video Recordings

Departmental Consent to Obtain TeachLivE Recorded Videos

Department of Education and Educational Psychology

Dear [Insert name of professor]
I am writing to you for consent to use recorded videos of the preservice teachers using the TeachLivE simulation at, to conduct my research, "The Effect of Data-driven Coaching using TeachLivE in a Preservice Teacher Program." These videos will be taken from the end of the 2016 fall semester through the duration of the spring 2017 semester. I am happy to work with you in any way possible to make this study as non-intrusive as possible.

Sincerely,
Doctoral Candidate

I, [Insert name of professor] hereby grant consent to Wes DeSantis having access to TeachLivE recorded videos taken from the end of the 2016 fall semester and the spring 2017 semester for his research.
Print Name: _____ Date: _____
Signature: _____

Professor Permission Form

Consent Form: Course Professor

Department of Education and Educational Psychology

Dear [Insert name of professor]

I am currently enrolled in the doctoral program for Instructional Leadership at state university. The program requires doctoral candidates to design and implement a research study as part of the dissertation requirement. Please accept this letter as a formal request on my behalf, for you and your class to participate in this research, which will be conducted during the spring semester of 2017.

The purpose of the research study is to explore the effects of data-driven coaching while using mixed-reality simulations (TeachLivE) in a preservice teacher program. The two groups in this study will be divided between two sections of a class that you are teaching in spring of 2017. During this semester, there will be three TeachLivE sessions as part of the curriculum. The class will be Educational Psychology II: Childhood and Adolescence. Either the section or participating students will be randomly selected to be the treatment group while the others will be the comparison group. Individuals in the treatment group will receive feedback from the researcher about the number and types of questions they are asked in the prior teaching session, including the prior semester, and be directed to form a plan to improve their higher-order questioning technique. At the end of the three sessions the comparison group will also receive a report of their data from each of the TeachLivE sessions. The researcher will also collect the post TeachLivE reflections that the participants complete.

This research study has been approved by the State University Institutional Review Board; protocol number [Insert # here]. I wish to thank you in advance for considering yourself and your class for participation in this study. If you would like to discuss the study with me, or have any additional questions, please do not hesitate to contact me via

Please keep a copy for your records.

Thank you,

Instructional Leadership

State University

I, _____, am a professor at State University. I acknowledge that Mr. DeSantis has made clear to me the purpose of this research study, identified all potential risks involved, and offered to answer any questions. I voluntarily grant my permission to have my class participate in this research study.

Printed Name *(Please print clearly)*: _____

Signature: _____ Date: _____

[Treatment Group]
Consent from Preservice Teacher: Form A

Department of Education and Educational Psychology

What the study is about: The purpose of this study is to explore how feedback about questioning strategies, when connected with best teaching practices, can create a positive impact on preservice teachers' lesson delivery.

What will happen in this study: If you agree to be in this study, the video taken from your Teachlive sessions in Fall 2016 and Spring 2017 will be analyzed by a researcher; you will be asked to complete a demographic survey; your GPA, and education course grades will be collected by the researcher Wes DeSantis; your reflection prompts will be reviewed from each lesson; and after each of the three TeachLive sessions, you will be asked to participate in a 20-to-30-minute interview about your TeachLive experience. At the end of the semester you will be asked to participate in a 30 to 45-minute focus group about your experiences teaching during the semester.

Risks and benefits: I do not anticipate any risks to your participation in this study. Participation in this study will not be related to your course grade. Your participation will also help us to improve the TeachLive experience for future teacher candidates.

Your information will be confidential. The records of this study will be kept private. In any sort of report that we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file and all videos will be under encryption protection; only the researchers will have access to the records.

Taking part is voluntary: Taking part in this study is completely voluntary. If you decide not to take part, it will not affect your current course grade or your future relationship with. If you decide to take part, you are free to withdraw at any time.

If you have questions: The researcher conducting this study is Wes DeSantis. Please ask any questions you have now. If you have questions later, you may contact Wes DeSantis at. If you have any questions or concerns regarding your rights as a participant in this study, you may contact the Institutional Review Board (IRB).

You will be given a copy of this form to keep for your records.
Statement of Consent: I have read the above information and have received answers to any questions I asked.

"The Family Educational Rights and Privacy Act of 1974 (amended in Jan. 1999), commonly referred to as FERPA, is a federal law that is designed to protect the privacy of and limit access to the educational records of students. No one outside the university shall have access to nor will the university disclose any information from a student's educational records without his/her written consent." Thus, by consenting to this study, you are also granting access for the researcher to look up your current GPA information. No other info about your private education records will be accessed by the researcher. "I know that the Family Educational Rights and Privacy Act of 1974 (FERPA) as amended protects the privacy of my student educational records and limits access to the information contained in those records." I am providing consent for the researcher of this study to be able to access my GPA until this study's approval expires.

I consent to take part in the study.

Your Signature _____ Date _____
Your Name (printed) _____
This consent form will be kept by the researcher for at least three years beyond the end of the study.

[Comparison Group]
Consent from Preservice Teacher: Form B

Department of Education and Educational Psychology

What the study is about: The purpose of this study is to explore how the simulation environment of TeachLive, when connected with best teaching practices, can create a positive impact on preservice teachers' lesson delivery.

What will happen in this study: If you agree to be in this study, the video taken from your Teachlive sessions in Fall 2016 and Spring 2017 will be analyzed by a researcher; you will be asked to complete a demographic survey; your GPA, and education course grades will be collected by the researcher Wes DeSantis; your reflection prompts will be reviewed; and at the end of the semester you will be asked to participate in a 30 to 45-minute focus group about your experiences teaching during the semester.

Risks and benefits: I do not anticipate any risks to your participation in this study. Participation in this study will not be related to your course grade. At the end of the study you will be given a summary of the collected data from your TeachLive sessions. Your participation will also help us to improve the TeachLive experience for future teacher candidates.

Your information will be confidential. The records of this study will be kept private. In any sort of report that we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file and all videos will be under encryption protection; only the researchers will have access to the records. **Taking part is voluntary:** Taking part in this study is completely voluntary. If you decide not to take part, it will not affect your current course grade or your future relationship with. If you decide to take part, you are free to withdraw at any time.

If you have questions: The researcher conducting this study is Wes DeSantis. Please ask any questions you have now. If you have questions later, you may contact Wes DeSantis at. If you have any questions or concerns regarding your rights as a participant in this study, you may contact the Institutional Review Board (IRB).
You will be given a copy of this form to keep for your records.
Statement of Consent: I have read the above information and have received answers to any questions I asked.

"The Family Educational Rights and Privacy Act of 1974 (amended in Jan. 1999), commonly referred to as FERPA, is a federal law that is designed to protect the privacy of and limit access to the educational records of students. No one outside the university shall have access to nor will the university disclose any information from a student's educational records without his/her written consent." Thus, by consenting to this study, you are also granting access for the researcher to look up your current GPA information. No other info about your private education records will be accessed by the researcher. "I know that the Family Educational Rights and Privacy Act of 1974 (FERPA) as amended protects the privacy of my student educational records and limits access to the information contained in those records." I am providing consent for the researcher of this study to be able to access my GPA until this study's approval expires.

I consent to take part in the study.

Your Signature _____ Date _____
Your Name (printed) _____
This consent form will be kept by the researcher for at least three years beyond the end of the study.

EdD in Instructional Leadership
Department of Education and Educational Psychology
Dissertation Registration Form

Student Wes DeSantis Date 5/1/18

Dissertation Title: The Effect of Data-Driven Feedback And Coaching Using a Mixed-Reality Simulation In a Preservice Teacher Education Program

Dissertation Committee Members: See attached Dissertation Approval Page

For Office Use Only.

Marcia A. B. Delcourt, PhD	Marcia A B Delcourt	05/12/18
Primary Advisor	Signature	Date
Marcia A. B. Delcourt, PhD	Marcia A B Delcourt	05/12/18
Program Coordinator	Signature	Date
Maryann Rossi, PhD	Maryann Rossi	5-31-18
Dean, School of Professional Studies	Signature	Date
Christopher Shankle, EdD		5.31.18
Associate Director, Division of Graduate Studies	Signature	Date